



## Calhoun: The NPS Institutional Archive DSpace Repository

---

Theses and Dissertations

1. Thesis and Dissertation Collection, all items

---

1986-09

### The Icarus illusion: technology, doctrine and the Soviet Air Force

Black, Steven K.

---

<http://hdl.handle.net/10945/21897>

---

*Downloaded from NPS Archive: Calhoun*



<http://www.nps.edu/library>

Calhoun is the Naval Postgraduate School's public access digital repository for research materials and institutional publications created by the NPS community.

Calhoun is named for Professor of Mathematics Guy K. Calhoun, NPS's first appointed -- and published -- scholarly author.

Dudley Knox Library / Naval Postgraduate School  
411 Dyer Road / 1 University Circle  
Monterey, California USA 93943



DUDLEY NOZ LIBRARY  
NAVAL POSTGRADUATE SCHOOL  
MCNURRY BLDG. MCNAUL A 95943-6002







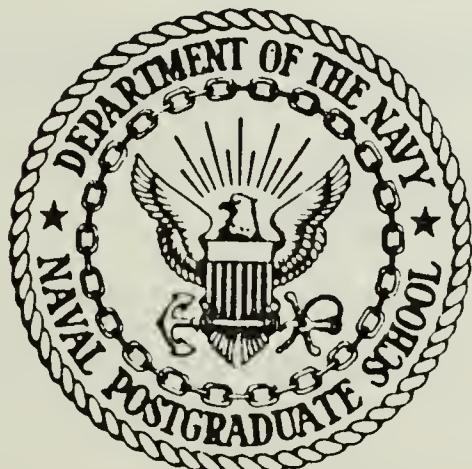






# NAVAL POSTGRADUATE SCHOOL

## Monterey, California



# THESIS

THE ICARUS ILLUSION:  
TECHNOLOGY, DOCTRINE AND THE SOVIET AIR  
FORCE

by

Steven K. Black

September 1986

Thesis Advisor

Jan A. Dellenbrant

Approved for public release; distribution is unlimited.

T230097



## REPORT DOCUMENTATION PAGE

1a REPORT SECURITY CLASSIFICATION UNCLASSIFIED		1b. RESTRICTIVE MARKINGS	
2a SECURITY CLASSIFICATION AUTHORITY		3 DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution is unlimited	
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE			
4 PERFORMING ORGANIZATION REPORT NUMBER(S)		5. MONITORING ORGANIZATION REPORT NUMBER(S)	
6a. NAME OF PERFORMING ORGANIZATION Naval Postgraduate School	6b OFFICE SYMBOL (if applicable) 56	7a. NAME OF MONITORING ORGANIZATION Naval Postgraduate School	
6c. ADDRESS (City, State, and ZIP Code) Monterey, California 93943-5000		7b. ADDRESS (City, State, and ZIP Code) Monterey, California 93943-5000	
8a NAME OF FUNDING/SPONSORING ORGANIZATION	8b. OFFICE SYMBOL (if applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER	
8c. ADDRESS (City, State, and ZIP Code)		10 SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO      PROJECT NO      TASK NO      WORK UNIT ACCESSION NO	

11. TITLE (Include Security Classification) THE ICARUS ILLUSION: TECHNOLOGY, DOCTRINE AND THE SOVIET AIR FORCE			
12. PERSONAL AUTHOR(S) Black, Steven K.			
13a. TYPE OF REPORT Master's Thesis	13b. TIME COVERED FROM _____ TO _____	14. DATE OF REPORT (Year, Month, Day) September 1986	15. PAGE COUNT 132
16. SUPPLEMENTARY NOTATION			

17. COSATI CODES FIELD      GROUP      SUB-GROUP			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number) Technology, Doctrine, Soviet Air Force, Air Employment Doctrine, MIG, SUKHOI, Acquisition, Aircraft Design, Strategy, Tactics.
---	--	--	---

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This thesis describes and analyzes the relationship between post-World War II Soviet fighter aircraft design and Soviet air employment doctrine. It tests the proposition that Soviet fighter aircraft are developed in response to design criteria established solely on the basis of military requirements. The results show that Soviet fighter design has not only progressed largely independently of prevailing doctrinal requirements, but appears to have driven the development of tactical air employment doctrine over the past forty years.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT <input checked="" type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT. <input type="checkbox"/> DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED
22a. NAME OF RESPONSIBLE INDIVIDUAL Jan A. Dellenbrant	22b. TELEPHONE (Include Area Code) (408) 646-2228
22c. OFFICE SYMBOL Dt	

Approved for public release; distribution is unlimited.

The Icarus Illusion:  
Technology, Doctrine and the Soviet Air Force

by

Steven K. Black  
Captain, United States Air Force  
A.B., University of Michigan, 1980

Submitted in partial fulfillment of the  
requirements for the degree of

MASTER OF ARTS IN NATIONAL SECURITY AFFAIRS

from the

NAVAL POSTGRADUATE SCHOOL  
September 1986

The Icarus Illusion:  
Technology, Doctrine and the Soviet Air Force

Steven K. Black  
Captain, United States Air Force  
A.B., University of Michigan, 1980

This thesis describes and analyzes the relationship between post-World War II Soviet fighter aircraft design and Soviet air employment doctrine. It tests the proposition that Soviet fighter aircraft are developed in response to design criteria established solely on the basis of military requirements. The results show that Soviet fighter design has not only progressed largely independently of prevailing doctrinal requirements, but appears to have driven the development of tactical air employment doctrine over the past forty years.

Master of Arts in National Security  
Affairs  
September 1986

Advisor: Jan A. Dellenbrant  
Department of National Security  
Affairs and Intelligence

Classification of thesis: Unclassified



## ABSTRACT

This thesis describes and analyzes the relationship between post-World War II Soviet fighter aircraft design and Soviet air employment doctrine. It tests the proposition that Soviet fighter aircraft are developed in response to design criteria established solely on the basis of military requirements. The results show that Soviet fighter design has not only progressed largely independently of prevailing doctrinal requirements, but appears to have driven the development of tactical air employment doctrine over the past forty years.

## THESIS DISCLAIMER

The views and judgments presented in this thesis are those solely of the author. They do not necessarily reflect official positions held by the Naval Postgraduate School, the Department of the Navy, the Air Force Institute of Technology, the Department of the Air Force, the Department of Defense, or any other US government agency or organization. No citation of this work may include references or attributions to any official US government source.

## TABLE OF CONTENTS

I.	INTRODUCTION .....	10
A.	PURPOSE .....	10
B.	METHODOLOGY .....	10
C.	ORGANIZATION .....	11
II.	THE SOVIET WEAPONS ACQUISITION PROCESS .....	13
A.	THE PARTICIPANTS .....	13
1.	The Politburo .....	13
2.	The Secretariat .....	14
3.	The Defense Council .....	14
4.	The Ministry of Defense .....	15
5.	The Defense Industry .....	16
6.	The Ministry of Aviation Ministry (MAP) .....	17
7.	The Military-Industrial Commission (VPK) .....	21
B.	STRENGTHS AND WEAKNESSES .....	21
III.	THE EVOLUTION OF SOVIET FIGHTER DESIGN .....	25
A.	1945-1953, THE GERMAN LEGACY .....	25
B.	1954-1964, A CHANGE IN EMPHASIS .....	34
C.	1964-1973, THE RISE OF GROUND ATTACK .....	44
D.	1973-1985, THE RISE OF AIR COMBAT .....	51
IV.	THE EVOLUTION OF AIR EMPLOYMENT DOCTRINE .....	61
A.	1945-1953, THE STAGNATION OF MILITARY DOCTRINE .....	61
B.	1954-1964, A PERIOD OF TRANSITION .....	65
C.	1964-1973, THE NUCLEAR PERIOD .....	74
D.	1973-1985, THE CONVENTIONAL PERIOD .....	77
	1. Introduction .....	77
	2. The Theater Strategic Conventional Operation .....	78

3. The Operational Maneuver Group .....	81
4. The Soviet Air Forces Reorganization .....	84
5. The Air Operation .....	89
V. QUANTIFYING THE PROBLEM .....	
A. THE COMPONENTS OF FIGHTER CAPABILITY .....	91
B. SCORING SOVIET FIGHTER TECHNOLOGY AND DOCTRINE .....	96
VI. TECHNOLOGY AND DOCTRINE IN PERSPECTIVE .....	
A. GROUND ATTACK .....	110
B. AIR COMBAT .....	114
C. TOWARD THE YEAR 2000 .....	116
APPENDIX A: THE DATA BASE.....	119
APPENDIX B: SAMPLE METHODOLOGY .....	124
BIBLIOGRAPHY .....	126
INITIAL DISTRIBUTION LIST .....	130

## LIST OF TABLES

I.	LIST OF VARIABLES USED IN FACTOR ANALYSIS .....	92
II.	CORRELATION COEFFICIENTS FOR FIGHTER MATRIX (FTRMAT) .....	93
III.	ESTIMATES OF COMMUNALITY .....	94
IV.	FACTOR DELINEATION .....	94
V.	UNROTATED FACTOR MATRIX .....	95
VI.	FINAL VARIMAX-ROTATED FACTOR MATRIX .....	95
VII.	TINDEXA VALUES FOR AIR DEFENSE INTERCEPTORS .....	97
VIII.	TINDEXA VALUES FOR AIR SUPERIORITY FIGHTERS .....	98
IX.	AVERAGE TINDEXA VALUES .....	99
X.	TINDEXG VALUES FOR GROUND ATTACK FIGHTERS .....	101
XI.	DISAGGREGATED TINDEX VALUES .....	102
XII.	DEPTHRATIO-MISSION RELATIONSHIPS .....	103
XIII.	DISAGGREGATED AVERAGE DEPTHRATIO VALUES BY PERIOD .....	104
XIV.	EVOLUTION OF SOVIET FIGHTER DESIGN AND AIR EMPLOYMENT DOCTRINE .....	109

## LIST OF FIGURES

1.	Location of Soviet Aircraft and Aircraft Engine Plants .....	19
2.	Location of German Aircraft Engine Plants, 1945 .....	26
3.	Disposition of Main German Aircraft Engine Plants .....	26
4.	Evolution of Thickness/Chord Ratio (1945-1953) .....	30
5.	Evolution of Combat Radius (nm) (1945-1953) .....	31
6.	Evolution of Maximum Thrust (lbs) (1945-1953) .....	31
7.	Evolution of Ground Run (ft) (1945-1953) .....	32
8.	Evolution of Wingsweep (degrees) (1945-1953) .....	32
9.	Evolution of Aspect Ratio (1945-1953) .....	33
10.	The Trend Toward Supersonic Flight .....	34
11.	Evolution of Thickness/Chord Ratio (1945-1965) .....	36
12.	Evolution of Aspect Ratio (1945-1965) .....	36
13.	MIG-21 FISHBED .....	37
14.	Evolution of Maximum Mach at Altitude .....	37
15.	Evolution of Wingloading (1945-1965) .....	38
16.	MIG-23 FLOGGER .....	39
17.	SU-7 FITTER .....	40
18.	Evolution of Maximum Thrust (lbs) (1945-1965) .....	40
19.	Evolution of Ordnance-Carrying Capability (lbs) (1945-1965) .....	41
20.	Evolution of Ground Run (ft) (1945-1965) .....	42
21.	SU-11 FISHPOT .....	43
22.	Evolution of Combat Radius (nm) (1945-1965) .....	43
23.	SU-15 FLAGON E/F .....	46
24.	Comparison of MIG-23 (top) and MIG-27 (bottom) .....	47
25.	Comparison of Panavia TORNADO and SU-24 FENCER .....	49
26.	Soviet Interest in Western Propulsion Systems .....	52
27.	Evolution of AI Radar Search Range .....	56
28.	Evolution of AI Radar Track Range .....	56

29.	Evolution of AAM Range .....	57
30.	Evolution of Thrust-to-Weight Ratio (lbs) (1945-1980) .....	57
31.	Evolution of Wingloading (1945-1980) .....	58
32.	Evolution of Long-Range Kill Capability .....	59
33.	Evolution of Maneuverability .....	60
34.	Evolution of Maximum Maneuverability and Maximum Kill-Range .....	60
35.	Request Sequence to Fire Nuclear Artillery .....	83
36.	Evolution of TINDEXA .....	99
37.	Evolution of TINDEXG .....	102
38.	Technology-Doctrine Convergence .....	106
39.	Components of a Modern Ground Attack Mission .....	111

## I. INTRODUCTION

After Daedalus had crafted the wings upon which he and his son would escape to safety, he gave very specific instructions to Icarus on how to use them to maximum effect. Daedalus warned Icarus not to fly too low, lest the wings become damaged by the salt water spray; nor should he fly too high, lest the sun melt the wax that held the structures together. . . . Growing over-confident in his new-found ability, the young boy forgot his father's warnings and, oblivious to the danger, climbed high into the sun, where his wings disintegrated, and Icarus perished in the sea below.

### A. PURPOSE

This thesis describes and analyzes the relationship between post-World War II Soviet fighter aircraft design and Soviet tactical air employment doctrine (that underlying body of principles that govern the operational use of tactical air assets). It is widely held that weapons procurement derives rationally from pre-existing doctrinal and operational requirements. Thus, the evolution of weapons design should "track with" the evolution of this tactical air employment doctrine. Further, not only should this doctrine not demand more of the available systems than they can deliver, it should not fail to fully exploit available capability. This research effort tests the proposition that Soviet fighter aircraft are developed in response to design criteria established solely on the basis of military requirements, as we understand them from available Soviet writings. The results show that Soviet fighter design has progressed largely independently of existing doctrinal requirements, and in fact, appears to have driven the development of tactical air employment doctrine over the past forty years.

### B. METHODOLOGY

The basic "method" of this research is to compare the most easily-observed characteristics and performance figures for most Soviet fighter aircraft with the employment concept prevalent at the time of each fighter's design. The data base from which the information on Soviet fighter aircraft (hereafter referred to simply as "fighters") is derived is one created by the author in late 1985 and early 1986. It includes only aircraft designed at the MIG (the acronym for Mikoyan-Gurevich, the names of the two designers who founded the design bureau) and SUKHOI (the

abbreviation for which is "SU") design bureaus since 1945.<sup>1</sup> Only those aircraft put into serial production are included in the data base. This does, however, include some aircraft produced in very small numbers, such as the MIG-23 FLOGGER A.

The data were all derived from unclassified sources. Where the necessary data were not available, the author derived them, either through simple "number-crunching" (as was the case, for example, in determining thrust-to-weight ratios or wingloading values) or through the use of simple linear regression (as in the case, for example, of determining non-afterburning maximum thrust based on a regression of maximum afterburning thrust, where the correlation coefficient was close to unity).<sup>2</sup>

### C. ORGANIZATION

Although the thesis discusses the evolution of fighter design and the evolution of air employment doctrine in the Soviet Union since the Second World War, Section II provides necessary background information on the Soviet weapons procurement process in general. It also offers some propositions about its systemic impact on fighter design and doctrinal development.

The chronological analysis of Soviet fighter development in Section III is formatted the same way as the chronological analysis of doctrinal development presented in Section IV. In each, the postwar period is divided into four parts: The Stalinist Period (1945-1953); the Khrushchev Period (1954-1964); a "nuclear" period (1964-1973), and; a "conventional" period (1973-1985). Taken together, these two sections argue that the evolution of Soviet fighter technology has largely driven Soviet air employment doctrine over the past forty years.

Section V attempts to quantify the problem, presenting the results of both factor and multiple-attribute utility analyses. The factor analysis follows from the assumption that the technological level of fighter capability can be viewed as a "combination of its

---

<sup>1</sup>The chief designer of the MIG design bureau (OKB) is currently R. A. Belyakov. Although it had been customary to honor a designer's successfully-produced product with the first two or three letters of the designer's name (e.g., MIG-15 for Mikoyan and Gurevich, SU-7 for Sukhoi, TU-16 for Tupolev), the practice followed in this thesis, as it appears to be in the Soviet Union, is to credit the OKB itself, rather than the particular designer. Thus, an aircraft recently designed by Belyakov will be referred to as a "MIG" product and bears the "MIG" designation. Similarly for the Sukhoi OKB, where the chief designer is currently E. A. Ivanov; products of the Sukhoi OKB bear the designation "SU," even where they may have been designed under Ivanov's tenure.

<sup>2</sup>The sources for the data base were *Modern Air Combat* (1983), *Aircraft of the Soviet Union* (1983), and *An Illustrated Guide to Future Fighters and Combat Aircraft* (1984) [all by Bill Gunston], as well as *Janes All the World's Aircraft*, *Aviation Week and Space Technology*, and *Interavia*.

component capabilities, each of which can be measured at an interval level.<sup>3</sup> The model derived from the multiple-attribute utility analysis is specifically designed to emphasize the growth in particular capabilities of different aircraft over a long period of time, as well as to permit a quasi-mathematical calculation of the relationship between doctrine and technology in the postwar period.

The final portion of the thesis (Section VI) considers a variety of factors external to the intrinsic characteristics of the aircraft itself--pilot skill, initiative, and tactics--in an effort to ground the quantitative portion of this research in a larger context.

---

<sup>3</sup>Allan Wesley LeGrow, *Measuring Aircraft Capability for Military and Political Analysis* (Master's Thesis, Naval Postgraduate School, Monterey, California, June 1976), p. 30.

## II. THE SOVIET WEAPONS ACQUISITION PROCESS

It is practically a cliche to identify the Soviet Union as a superpower primarily, if not solely, because of its military prowess. Numerous scholars have commented on the "backwardness" that characterizes the overall Soviet economy. At the same time, however, the Soviet Union clearly has a capacity to produce weapons of a sufficiently capable quality and in vast enough numbers to "qualify" as one of the world's two superpowers. The discrepancy between the civilian and military sectors of the Soviet economy appear to be so great that one is tempted to conjure up an image of two distinct economies; one that produces sophisticated military hardware roughly comparable to Western equipment, and another one that produces consumer goods only erratically and at all times of a significantly inferior quality, compared both to their Western counterparts and to the higher-quality workmanship found in and priority attached to items produced in the military sector.

This section of the thesis describes, in general terms, how the Soviet political and military leadership acquires weapon systems. It will be shown, in particular, that the Soviets are able to acquire weapons of high quality and in enormous number in the midst of an economy riddled with waste, inefficiency, and built-in impediments to innovation, at the same time as the process imposes certain costs on the design system.

### A. THE PARTICIPANTS

#### 1. The Politburo

Military policy in general, and weapons acquisition in particular, take place within a dual government-Party structure. For the most part, the Communist Party of the Soviet Union (CPSU), specifically the Politburo and the Secretariat, formulate policy, while the governmental apparatus ratifies and implements those decisions. Within the CPSU, the Politburo is the most important organization involved in the Soviet weapons acquisition process. The Politburo both regularly participates in defense-oriented decisionmaking and retains the power to initiate, cancel or modify programs that capture its interest.<sup>4</sup>

---

<sup>4</sup>The Politburo considers all "large, non-recurring expenditures," budgets, numbers of weapons, and programs with cost-overruns. Arthur Alexander, *Decision-Making in Soviet Weapons Procurement* (London: Adlard and Son Ltd., 1978), p. 9.

The Politburo's intervention has been significant in the past; it is well-known that Stalin was personally involved in the weapons acquisition process, particularly involving nuclear weapons. Khrushchev, too, was intimately involved in the effort to develop the Soviet space program and ballistic missiles. Currently, the extent of the Politburo's involvement may range from minimal to maximal. This latter type of activity is most likely for "new in principle" weapons, examples of which are nuclear weapons, ballistic missiles, and directed-energy "beam" weapons.<sup>5</sup> However, while devolution of authority to the working level has been described as one of the major characteristics of the Brezhnev era,<sup>6</sup> it remains to be seen what will be said of the Andropov, Chernenko and Gorbachev regimes.

## 2. The Secretariat

Another important CPSU organization is the Central Committee Secretariat. In addition to its other functions, it is responsible for overseeing policy implementation. There are approximately ten Secretaries, each with specific areas of responsibility. One of these is probably charged with overseeing heavy industry and defense production. This very powerful post was once held by Leonid Brezhnev, and later by Dmitri Ustinov, who became the Minister of Defense in 1976. Subordinate to this Secretary is the Department of Defense Industry, which

is responsible for overseeing Party affairs in the military-production ministries, and also for the implementation of weapons research and development (R&D) and production policies.<sup>7</sup>

## 3. The Defense Council

Although the CPSU formulates and implements defense policy, recommendations as to what policy should be in the first place probably come from the Defense Council. This organization "links politicians and the military at the highest level."<sup>8</sup> A great deal of secrecy surrounds the Defense Council, both with respect to its

---

<sup>5</sup>Alexander, *Decision-Making*, pp. 35-39.

<sup>6</sup>Jerry Hough, "The Brezhnev Era: The Man and the System," *Problems of Communism* March-April 1976.

<sup>7</sup>"The Secretary for Defense Production, and perhaps also his subordinate department, are said to be a link between the political and military leadership." Kenneth A. Myers and Dmitri Simes, *Soviet Decisionmaking, Strategic Policy, and SALT* (Washington, D.C.: Center for Strategic and International Studies, Georgetown University, 1974), ACDA/PAB-243, p. 26.

<sup>8</sup>Alexander, *Decision-Making*, p. 14.

membership and to its precise functions.<sup>9</sup> Alexander says that the Defense Council is

primarily concerned with major weapons developments and procurement programmes, manpower levels, and budget allocations. In line with its budgetary responsibilities, the Defence Council provides the guidelines at the beginning of the planning process and would make recommendations to the Politburo regarding the final plans of the Minister of Defence and military production ministries . . . . the Defence Council approves weapons programmes.<sup>10</sup>

He concludes that the Defense Council is probably the most important political policy-making body for weapons procurement in the Soviet Union.

#### 4. The Ministry of Defense

Another key participant in the acquisition process is the Ministry of Defense, under which are included centralized ministerial organs, the General Staff, and the five "services." The central Ministry organs provide the initial guidance and control for weapons development and production. The separation of functions between the Ministry "proper" and the General Staff provides a system of "checks and balances."<sup>11</sup> The General Staff itself also plays an important role. All requests for new systems flow through the General Staff and it adjudicates inter-service disputes over resource allocations. It is also possible that the General Staff or one of its directorates serves as the operational staff of the Defense Council, advising it and making recommendations to it. Because the General Staff is the main repository of professional military expertise, its influence on the weapons acquisition process can be substantial.<sup>12</sup>

---

<sup>9</sup>Vernon Aspaturian has suggested that there is no statutory composition on the Defense Council, "that its membership can be expanded or contracted depending upon circumstances." He further suggests that the Council's full members may be the General Secretary, the Chairman of the Presidium of the Supreme Soviet, the Second Secretary, the Chairman of the Council of Ministers, the Minister of Defense, the Chairman of the KGB, and the Minister of Foreign Affairs. Advisory members include the Chairman of the Military-Industrial Commission (VPK), the Chief of the General Staff of the Armed Forces, the Commander-in-Chief of the Warsaw Pact Forces, a First Deputy Defense Minister without portfolio, and the Director of the Main Political Administration (NPS lecture, 13 August 1985).

<sup>10</sup>Alexander, *Decision-Making*, p. 15.

<sup>11</sup>This separation of functions would provide the Minister with an independent check on General Staff planning and activities. Alexander, *Decision-Making*, p. 17. The planning cycle establishes a calendar for resource allocation, which represents a rigidity in the intra-plan period. Even with high priority military production, some "newly-determined" priorities cannot be reflected until the next Five Year Plan. Vernon Aspaturian, "The Soviet Military-Industrial Complex--Does It Exist?" *Journal of International Affairs* vol. 26, no. 1, 1972, p. 26.

<sup>12</sup>The Staff's control of military information permits it to exert significant influence on national military policy by presenting issues and options to major decisionmaking forums in ways which favor preferred outcomes. Ellen Jones, "Defense R&D Policymaking in the USSR," in Jiri Valenta and William Potter, eds.,

Finally, within the Ministry of Defense there are also the five services. Most of the requests for new weapons, and the number of systems required, come from the services. Each service directs some weapons development and each is responsible for the oversight required at factories, research institutes, and design bureaus.<sup>13</sup> Requests for new or improved weapons from within the services could come from the various scientific-technical committees (which would be alert to new technological possibilities), the operations staff (which would be sensitive to mission requirements), or the field commanders (who would promote even more applications-oriented requirements).<sup>14</sup> Within each service there is a Deputy Commander in Chief for Armaments, whose functions include

specification of 'tactical-technical requirements' for new weapons systems; representation on the state acceptance commissions which evaluate new designs and prototypes; and administration of<sup>15</sup> the teams of military representatives (voenpredy) at defense production plants.

These organizations, which are the services' main technical directorates, are "[the] primary interface between the MOD [Ministry of Defense] consumer and the developer/producer [of new weapons systems]."<sup>16</sup>

### 5. The Defense Industry

On the purely economic side of the house, implementation of defense policy is the responsibility of the governmental administrative apparatus--the Council of Ministers. The State Planning Commission (GOSPLAN), which operates under the Council of Ministers, coordinates the thousands of organizations producing all the products throughout the economy, including those needed in the defense sector.

---

*Soviet Decisionmaking for National Security* (Los Angeles: Center for International and Strategic Affairs, University of California, 1984), p. 125.

<sup>13</sup>Jones, "Defense R&D," p. 125.

<sup>14</sup>Alexander, *Decision-Making*, p. 19. The orientation or bias of requirements would thus seem to be partly determined by their origins: as one moves from the scientific-technical committees to armaments directorates to operations staff to field commands, one would expect a shift from technical to mission influence.

<sup>15</sup>John A. McDonnell, "The Soviet Weapons Acquisition System," in *Soviet Armed Forces Review Annual* vol. 3 (Gulf Breeze: Academic International Press, 1979), p. 178.

<sup>16</sup>Jones, "Defense R&D," p. 125.

Military production, however, is administratively segregated from civilian production.<sup>17</sup> The defense industrial sector consists of nine main ministries: four weapons production ministries, and five component production ministries.<sup>18</sup> Among these ministries, the one that is responsible for the design, development, and production of all aerodynamic systems is the Ministry of Aviation Industry (MAP).

#### 6. The Ministry of Aviation Ministry (MAP)

The MAP, like most of the other industrial ministries, plans, controls, and oversees the operation of research institutes, design bureaus, and production plants. Its organization structure is typical of most defense industry ministries.<sup>19</sup> The scientific research institutes (NII) of the defense industry carry out both basic and applied research.<sup>20</sup> Most research projects are financed from the state budget allocated to the MAP, but there are also some external contractual agreements with other ministries and organizations. The NII's play a critical role in the design of new weapon systems through the compilation of their research and test results into handbooks, which are then distributed to the design community. These handbooks contain material, structural, and procedural specifications for all approved aerodynamic systems and components. The results of the NII research are made available because many of the design bureaus do not have the staff or facilities to carry out their own research. The publication of handbooks for designers was instituted to establish common, proven technical guidelines and keep designers abreast of new developments.<sup>21</sup>

---

<sup>17</sup>The military plan is sent separately to production facilities, which must satisfy its goals as a first priority. Alexander, *Decision-Making*, p. 20.

<sup>18</sup>The "weapons production" ministries are the Ministry of Aviation Industry (*aircraft, engines, parts, air-breathing missiles*), Ministry of Defense Industry (*conventional weapons*), Ministry of Shipbuilding Industry (*ships and submarines*), and; Ministry of General Machine Building (*ballistic missiles*). Among the "component production" ministries are the Ministry of Electronics Industry (*electronic components*), Ministry of Radio Industry (*electronic products*), Ministry of Medium Machine Building (*nuclear weapons*), Ministry of Machine Building (*ammunition*), and; Ministry of the Means of Communication (*communications equipment*). Alexander, *Decision-Making*, p. 22.

<sup>19</sup>Anton Dobler, "The Soviet Aviation Industry," Paul Murphy, ed., *The Soviet Air Forces* (Jefferson: McFarland & Company, 1984), p. 81.

<sup>20</sup>Work in the research institutes includes aerodynamic and structure research primarily in support of the aircraft design bureaus, engine research and testing for the propulsion design bureaus, and applied research on metallic materials. Dobler, "Soviet Aviation Industry," p. 84.

<sup>21</sup>McDonnell, "Soviet Weapons Acquisition," p. 181.

This arrangement of keeping applied research separate from design and development has several mixed consequences. On the one hand, it means that funding for applied research does not depend on specific weapons requirements. Also, there is a strong institutional tendency towards commonality of parts, which has a desirable effect on such things as ease of maintenance and sustainability. On the other hand, while it is true that designers typically take what is available from the research institutes, rather than "gold-plating" new systems, it also means that there is little or no apparent incentive to incorporate new technologies.<sup>22</sup>

The design bureaus (OKB's) are the "managers" of the acquisition process. Because they are located "at the central node between research and product, user and planner," they supply the leadership and coordination necessary in the chaotic processes of an unresponsive economy.<sup>23</sup> An especially important part of the design criteria is "producibility." This means that the designer must work closely with the production plant and make sure that the design he is proposing does not draw upon hard-to-get resources or components, or exceed the technological capability of the production plant. The chief designer of the OKB has a great deal more autonomy in running his organization than most managers enjoy elsewhere in the Soviet economy and is personally associated with the success or failure of his project. As an illustration, the products (that is, the aircraft) have come to be identified by the first two or three letters of the designer's name: MIG-25 (Mikoyan and Gurevich), SU-24 (Sukhoi), TU-22M (Tupolev). This practice is still followed and reflects the prestige that redounds to successful designers.<sup>24</sup>

Even with all the administrative positions, research institutes and design bureaus, the bulk of resources comprising the Soviet aviation industry are the series

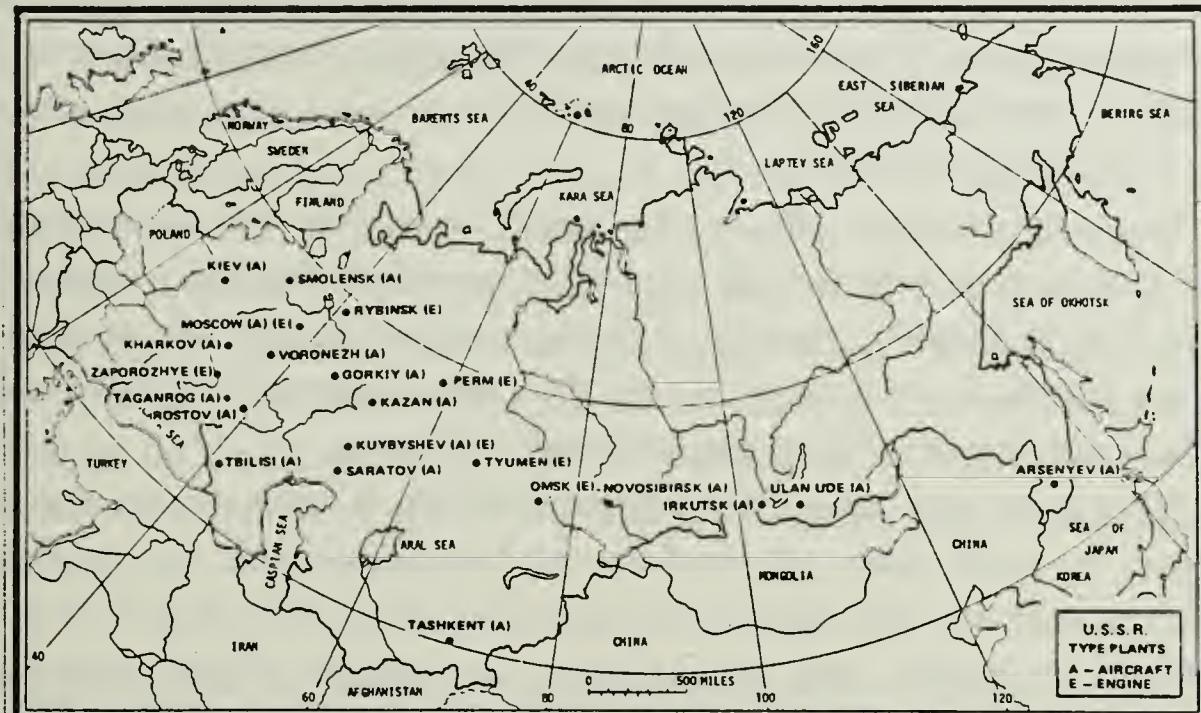
---

<sup>22</sup>This does not mean that there is no innovation or technological development present--only that it has not manifested itself clearly to Western observers. It will be shown later that, not only is there reason to be cautious about the notion of "Soviet design heredity," but there has in fact been significant technological advancement in the fighter design community.

<sup>23</sup>Alexander, *Decision-Making*, p. 24.

<sup>24</sup>McDonnell, "Soviet Weapons Acquisition," p. 182.

production plants. The locations of some of these plants are shown in Figure 1. These series production plants try to be as self-sufficient as possible, due to the problems in supply characteristic of the Soviet economy. Nevertheless, there are a number of other plants involved in the production of components, even if the subcontracting base is not nearly as extensive in the USSR as it is in the US.



Source: Dobler, "Soviet Aviation Industry," p. 90.

Figure 1. Location of Soviet Aircraft and Aircraft Engine Plants

In the same way that OKB's tend to specialize by aircraft type, so too do the production plants try to specialize (bombers, transports, fighters, helicopters). Once a design has been selected, the factory responsible for series production is "subordinated" to the originating design bureau. The OKB dispatches teams to help the factory "tool up" and to oversee production in other ways.

So long as production continues, the [design bureau] retains the authority to monitor manufacturing techniques to ensure that the integrity of the design is not violated. In this they are both supported and cross-checked by the military representatives [voenpredy] who exercise quality control and certify that production is acceptable [to the Ministry of Defense and the Air Force]. Because of the evolutionary nature of Soviet weapons design, it is not uncommon for a given factory to produce several generations of a particular system . . . designed by the same [OKB]. Thus, a tradition may develop . . . [that leads] to an almost permanent relationship . . . it is reasonable to suspect that factory managers prefer, other things being equal, to retain [OKB] 'bosses' with whom they have built up a satisfactory working relationship.<sup>25</sup>

In addition to long familiarity with each other, the lengthy tenures of military industrial managers, designers, and government administrators, has helped to create a community of shared interests and values that induces "a strong sense of the value of continuity in design and production."<sup>26</sup>

In this environment, things are less competed for than they are "arranged." Weapons tend to be developed along very clearly established lines, and assignments tend to be fixed by tradition, especially where technologies are stable. In the event of entirely new systems or advanced technology, there may be multiple prototypes and a side-by side competition to select a design for series production.

While in the past, the primary measure of success in military production was quantitative, in recent years the emphasis has increasingly been on qualitative improvements, especially with regard to the application of new technology.<sup>27</sup> Through modernization, expansion, and mechanization, as well as higher wages and non-pecuniary compensatory incentives such as housing, the Soviet aviation industry is now on a par with Western aircraft industries in many areas.<sup>28</sup> As mentioned briefly

---

<sup>25</sup>McDonnell, "Soviet Weapons Acquisition," pp. 183-184.

<sup>26</sup>Alexander, *Decision-Making*, p. 23.

<sup>27</sup>General Secretary Brezhnev named the 1976 Five Year Plan the "Plan of Quality." Alexander, *Decision-Making*, p. 60.

<sup>28</sup>"In the areas of forging, extrusion, metal removal, and metal joining, developments and applications are generally on a level with those of the West. Within selected categories of these fields--including forging and extrusion press construction, electro-discharge and ultrasonic machining, glue-welding, electro-slag welding, pulsed arc and magnetic arc welding--Soviet technology is advanced. Heavy presses used in aircraft construction include the world's largest forging press (70,000 metric ton capacity) and a 20,000 metric ton capacity extrusion press. Emphasis is now being given both to improving the fabrication of aircraft structures from conventional materials and to advancing the state of the art in high-temperature materials fabrication and in the construction of lightweight structures. In some areas where technology lags behind Western countries, e.g., in advanced computer-controlled machine tools and equipment process controls, foreign equipment has been purchased [or stolen] to fill existing gaps or to stimulate indigenous development." Dobler, "Soviet Aviation Industry," p. 93.

earlier, and in addition to the quality control function exercised at the production plants by the OKB, the main technical directorates of the services also dispatch to the factory teams of observers. These are the military representatives (voenpredy), whose functions are also of a quality control nature. The close involvement of the military representatives is intended to elicit a measure of producer responsiveness quite uncommon elsewhere in the Soviet economy. "This . . . [presence] helps explain the remarkable contrast between the level of Soviet military and civilian technology."<sup>29</sup>

### 7. The Military-Industrial Commission (VPK)

Finally, there is one last organization which plays a very important role in Soviet weapons acquisition: the Military-Industrial Commission (VPK). In fact, the VPK is widely held to be the single most powerful and important organization involved in defense production. Holloway suggests that the VPK may be an executive arm of the Defense Council,<sup>30</sup> while Alexander states that it may be answerable to the Secretary for Defense Production of the Central Committee.<sup>31</sup> Regardless, the VPK is made up of the top executives of the key defense manufacturing industries and coordinates the development of all Soviet weapons, as well as the acquisition of Western technology. A recent US Department of Defense report characterizes the VPK

as the expediter for weapons development projects . . . [It] is the principal Soviet military instrument for eliminating<sup>32</sup> or circumventing the inefficiencies characteristic of the Soviet economic system.

## B. STRENGTHS AND WEAKNESSES

Thus, the Soviet military economic sector in general, and the weapons acquisition process in particular, does indeed differ in significant ways from the civilian sector of the economy. For example, in the military sector, the "customer" (i.e., the Ministry of Defense) plays a dominant role. This is in sharp contrast to the typical producer-customer relationship in the civilian sector, in which the buyer is truly at the

---

<sup>29</sup>Jones, "Defense R&D," p. 126.

<sup>30</sup>David Holloway, *The Soviet Union and the Arms Race* (New Haven: Yale University Press, 1983), p. 111.

<sup>31</sup>Alexander, *Decision-Making*, p. 21.

<sup>32</sup>*Soviet Acquisition of Militarily-Significant Western Technology: An Update* (Washington, D.C.: Department of Defense, 1985), p. 4.

mercy of the producer.<sup>33</sup> There are at least two ways in which this "dominance" by the buyer is reflected. The first, and probably the most important, is the system of priority associated with military production. In the absence of an automatically-functioning market mechanism, such as prices that reflect cost, all criteria for military production must be bureaucratically determined. The determination to accord priority to one or another program is sufficient to transfer scarce resources to the military sector without bidding up their prices. The tendency for these scarce resources to flow in the military production sector of the Soviet economy means that there is no immediate market penalty (higher prices), however, it also means that Soviet costing for defense typically understates capital input.<sup>34</sup>

A second way in which the buyer-producer relationship is reversed from its "normal" Soviet quality is that there is a highly-structured system of controls, enabling the "customer" to exercise a kind of "oversight" with respect to the quality of the system under production. In fact, "the military customer is given the right to reject production which does not meet its standards."<sup>35</sup> There are a variety of means and instruments by which this quality control is assured. These include very specific written requirements concerning the minimal operational capabilities the new system of to possess, a willingness to budget vast research and procurement expenditures, a formal assignment to design and production facilities of military officers with wide responsibility for ensuring quality control, and a healthy disregard for the niceties of procedure, which allows the political leadership to intervene anywhere in the process when required. The defense sector's relationship to the civilian sector in the Soviet economy has been characterized as an island of excellence in a sea of mediocrity.

Nevertheless, despite these differences between the two sectors, the military sector does share certain characteristics with the rest of the Soviet economy. It is, after all, a centrally-planned, socialist organization in which production is allocated via non-economic means. That is, production is determined by political preference, rather than "through the market." As in other parts of the Soviet economy, the defense

---

<sup>33</sup>McDonnell, "Soviet Weapons Acquisition," p. 175.

<sup>34</sup>This argument is not true across the board: for example, in many cases, wages are higher in the defense-oriented industries, precisely in to attract "scarce" engineering talent and skilled labor. For the most part, however, if resources are needed to fulfill military production requirements, it is sufficient to put the full weight of the political structure behind the levy--no economic "incentive" is needed where political power is unitary and all-encompassing.

<sup>35</sup>McDonnell, "Soviet Weapons Acquisition," p. 175.

sector must live with the optimistic planning targets that often create shortages of necessary resources. This outright lack, due to administratively-mandated quantitative allocations, means that resources on hand are not fungible; "a simple money budget is not adequate to guarantee the availability of resources that have not been planned and allocated in detail."<sup>36</sup> Unreliable supplies engender an environment in which producers are reluctant to innovate with regard to finding new suppliers and new components. The lack of competition generates no incentives to differentiate products. This state of affairs in the military production production sector, as in the civilian sector, results in a strong tendency toward conservatism in both product design and development processes. The "risk-avoidance" characteristic of the Soviet society as a whole also has important consequences for the Soviets' ability to integrate and make full use of new technology. This systemic weakness will be addressed in greater detail later in this thesis.

Another characteristic of the military sector found as well in the civilian part of the economy is a result of the supply problem endemic to Soviet industry--that is the pursuit of autarky by ministries, through the vertical integration of important supply industries. This is quite common in the defense industry, but especially so in the Ministry of Aviation Industry, in which

90 to 95 percent of all aviation production (airframes, aeroengines, instruments, avionics)<sup>37</sup> is concentrated in the enterprises of the Ministry of Aviation Industry.

It is not clear whether the "priority system" allows vertical integration to take place in order to offset systemic problems, or is so wholly ineffective that the defense industry must evolve that way in order to survive.

Overall, the Soviet bureaucratic environment appears optimized to meet the special needs of the Soviet weapons acquisition process. It has taken advantage of the strengths and avoided many of the weaknesses of the Soviet technical and industrial base. Specifically, the organizational structure tends to develop technically-mature

---

<sup>36</sup>Alexander, *Decision-Making*, p. 30.

<sup>37</sup>Holloway, *The Soviet Union and the Arms Race*, p. 119.

weapons systems and avoids the typical sloppiness of Soviet civilian production. In addition, the Soviets are sometimes able to streamline an otherwise inflexible process to accommodate what is new and technically challenging.

Nevertheless, a significant weakness in the Soviet system is the general lack of incentives for technological advances or innovation, either in the weapons being produced or the production processes themselves. With production quotas and responsibilities determined by government fiat, there is no spur to use the technology to increase product differentiation. The strongest preference by far, on the part of both designers and producers, is to supply systems that emphasize continuity with earlier, sanctioned practices and capabilities.

When technological advances do occur, they are likely to be oriented toward one application and to be ill-integrated into or non-existent in other areas. For example, a new machine tool designed for a particular purpose on the assembly line is unlikely to be incorporated into any process other than that for which it was specifically designed, bought or stolen. In the case of Soviet fighter aircraft, this means that while technological advances do occur, they do so erratically and unevenly--their benefits accrue to one type of aircraft at a time, rather than raising the overall capability of the Soviet fighter force, or even the design and production community as a whole. Section III will address the precise nature of these technological improvements in Soviet fighter aircraft over the past forty years, with a view to laying the groundwork for a close look at the evolution of Soviet air employment doctrine in Section IV.

### III. THE EVOLUTION OF SOVIET FIGHTER DESIGN

#### A. 1945-1953, THE GERMAN LEGACY

The development of postwar Soviet fighters has its roots, more than anywhere else, in German design and production facilities. Because of British and American strategic bombing, the German aircraft industry was concentrated in the eastern part of Germany. When the Soviet Army swarmed into Germany at the end of the war, approximately 80% of Germany's aircraft industry fell into Soviet hands (see Figure 2, next page). Production facilities all over eastern Europe were seized by the Soviets. In Czechoslovakia, operational Messerschmitt-262 aircraft were captured, as well as several types of jet aircraft engines.<sup>38</sup> Entire factories were disassembled and removed to the Soviet Union (see Figure 3, page 27).

The Soviets also seized numerous precision tools, instruments, machine tools, and facilities for their production. In addition to all the above-listed material resources, the Soviets captured a number of important people in the German design community. These included Dr. Gunther Brock (in charge of the German experimental aeronautics institute, Deutsche Versuchsanstalt fur Luftfahrt in Berlin), Rudolph Rental (Messerschmitt's project engineer for the ME-163 and ME-263), Dr. Adolph Betz (Germany's foremost authority on swept-wing aircraft), and Siegfried Gunther (a senior designer at Heinkel). In addition to these, some German estimates as to the total number of people taken from Germany to the Soviet Union run as high as 300,000, including production workers.<sup>39</sup>

These assets "paid off" for the Soviets because very soon after the war, Soviet design bureaus began to produce new fighter designs incorporating the technologies captured in Germany and making use of production facilities removed to the Soviet Union. Of particular significance, many designs began to incorporate swept wings. The Germans' operational ME-262 jet fighter had only a slight sweepback

---

<sup>38</sup>Among them were: the Walter 4,400 lb. thrust rocket engine, which powered the ME-163; the blueprints for the S-011, an advanced Heinkel jet engine; and samples of Bayerische Motoren Werke's BMW 003 coaxial turbojet, which would in time power some of the first Soviet jet fighters. Asher Lee, *The Soviet Air Force* (London: Duckworth, 1961), p. 73.

<sup>39</sup>Asher Lee, *The Soviet Air and Rocket Forces* (New York: Praeger, 1959), pp. 234-235.



Source: US Strategic Bombing Survey, "Aircraft Industry Survey," Figure VII-2, based on data from the German Air Ministry, cited in Anthony Sutton, *Western Technology and Soviet Economic Development, 1945-1965* (Stanford: Hoover Institution, 1973), p. 256.

Figure 2. Location of German Aircraft Engine Plants, 1945

Type of engine	Location produced	Total production 1939 - 1944	Total production Dec 1944	Disposal of plant in 1945
Daimler-Benz (603)	Stettin	3582	250	Probably removed to U.S.S.R.
Daimler-Benz (601,603,606)	Berlin, Marienfelde	—	65	Not known
Daimler-Benz (601,605,606,610)	Bussing (Brunswick)	13,805	—	Not removed to U.S.S.R.
Daimler-Benz (601,605)	Henschel (Kassel)	13,119	600	Not removed to U.S.S.R.
Daimler-Benz (605)	Manfred Weiss (Budapest)	1,189	—	
Daimler-Benz (605)	Steyr	1,885	65	
Daimler-Benz (603)	Prague	311	76	
Daimler-Benz (603)	Austria (Ostmark)	2,890.	77	
Daimler-Benz (601,605,606,610)	Genshagen	30,833	700	100 percent removed to U.S.S.R.
Daimler-Benz (601,605,606,610)	Goldfisch underground (Heidelberg)			80 percent removed at end of 1945
BMW (801)	Allaco-Munich *	17,529	526	82 percent removed at end 1946
BMW (801)	Klockner (Hamburg)	4,206	150	Not removed to U.S.S.R.
BMW (801)	Spandau (Berlin)	5,695	326	Probably removed
BMW (132)	Eisenach	4,099	—	100 percent removed to U.S.S.R.
BMW (323)	Zuhlsdorf	3,227	plan 2500 month by September '45	100 percent removed to U.S.S.R.
Junkers (004,012)	Mäldestein (Dessau)	—	—	100 percent removed to U.S.S.R.
Junkers (004)	Kothen	—	—	100 percent removed to U.S.S.R.
Junkers (004)	Nordhausen	—	—	100 percent removed to U.S.S.R.
Junkers (003)	Magdeburg	—	—	100 percent removed to U.S.S.R.

Source: *Strategic Bombing Survey*, "Aircraft Division: Industry Report," Number 84 (January 1947), Table VII-1. Sutton, *Western Technology*, pp. 259-260.

Figure 3. Disposition of Main German Aircraft Engine Plants

(approximately 15 degrees), but there had been experimental prototypes with fully-swept wings.

The MIG-15, which is the first aircraft in this thesis' data base, appears to have been based on German data compiled for the sweptback version of the Messerschmitt-262. The original aircraft was designed in 1946. That same year, the Soviets purchased 55 Rolls-Royce centrifugal compressor-type turbojet engines from the British. These engines were better suited to Soviet production methods; they were simpler than the German axial flow designs the Soviets had until then been attempting to copy.<sup>40</sup> In 1956, USAF General Nathan Twining toured the Moscow plant in which the Soviet copy of the Rolls-Royce engine was produced and noted that it was equipped with machine tools from several western countries, including the United States.<sup>41</sup> The new British powerplants available to the Soviets, as well as the benefit of German wind tunnel test data on swept-wing designs, enabled the MIG-15 to approach the "sound barrier."

Even so, the Soviets, like others trying to increase flight speeds, experienced problems in the transonic region. This is a category of flight speeds in which the airflow around the aircraft is partly subsonic and partly supersonic (.7 Mach to Mach 1.3). Airflow velocity above the wing's surface is always greater than the aircraft's flight speed. When the flight Mach number increases, so do the local velocities at the thickest part of the wing. At some point, usually around .7 Mach, the local maximum velocity reaches Mach unity (Mach 1.0). The flight Mach number at that point is called the critical Mach number.

At free-stream air speeds above the critical Mach number, a number of undesirable flight characteristics develop, such as local shock waves on the wing surface. At slightly higher speeds, one encounters the drag-rise Mach number (or force divergence Mach number), at which the drag coefficient increases, the lift coefficient decreases, and there are unwelcome changes in the pitching moment coefficient. These characteristics of transonic flight cause local stall situations on the wings, leading to uncontrolled rolling. They also contribute to "tuckunder," in which the nose has a tendency to pitch down. The shock wave produced by supersonic flight can also cause buffeting, usually caused by turbulent air flowing around the horizontal stabilizers.

---

<sup>40</sup>Sutton, *Western Technology*, p. 264.

<sup>41</sup>*Aviation Week and Space Technology*, 2 July 1956, p. 29.

Yet another difficulty encountered in this region is "buzz," the rapid oscillation of control surfaces. Buzz causes early metal fatigue and difficulty in using non-powered control mechanisms. These are the sorts of problems the Soviets encountered with the MIG-15. It had many faults, including a

serious tendency to stall [and] spin in tight turn[s], poor behavior at any high angle of attack [even low speed] and progressively worse buzz and snaking as [the] Mach number rose beyond 0.88.<sup>42</sup>

These deficiencies can be overcome, or at least ameliorated, by a variety of measures. Clearly, the problem is one of getting the critical Mach number and the drag-rise Mach number up as high as possible for a given free-stream airspeed. This can be done by decreasing the wing's thickness (measured by the thickness/chord ratio), or increasing the wing sweep (which has the effect of decreasing the aspect ratio). Each of these has advantages and disadvantages. The choice depends, theoretically, on the mission requirements of the aircraft being designed.

Both sweeping the wings and reducing the thickness/chord ratio will delay the onset of the critical Mach number and the drag-rise Mach number. In both cases, however, the lift coefficient will also fall. The lower lifting ability of the wing is likely, all other things being equal, to require higher takeoff and landing speeds, which entail a longer ground run and longer runways. This is a significant consideration if a force planner wants to use aircraft "at the front;" that is, at makeshift airfields and landing strips close behind the leading edge of the combat area. Increasing the wing sweep also increases induced drag and can pose stability problems. Decreasing the airfoil thickness poses structural problems and actually results in a heavier wing than would be the case if it were thicker. Finally, because the wing normally has a considerable amount of usable volume, decreasing its thickness will reduce fuel-carrying capacity, in turn affecting the combat radius of the aircraft.

Clearly a designer faces a number of compromises and tradeoffs in the determination of these characteristics. The evolution of these characteristics in the aircraft designed at the MIG OKB from 1945-1953 represent a clear intention to pursue higher flight speeds, seemingly regardless of the impact on other flight characteristics. Figure 4 (next page) shows the evolution of thickness/chord ratio from

---

<sup>42</sup> Bill Gunston, *Aircraft of the Soviet Union* (London: Osprey Publishing, 1983), p. 175.

1945-1953. As the MIG OKB moved from one airframe design to the next (MIG-15 to MIG-17 to MIG-19), it progressively decreased the thickness/chord ratio. Internal fuel tankage decreased only slightly, however, due most likely to the fact that each new design was longer than its predecessor. Combat radius did not suffer because new iterations of powerplants were increasingly efficient (see Figure 5, next page). Maximum thrust also increased, incorporating for the first time an afterburner in the MIG-17 FRESCO C (Figure 6, page 31). The drop in the ground run for the MIG-19 series reflects the replacement of the VK-1F powerplant with two new RD-9 series engines (Figure 7, page 32). Wingsweep was increased by ten degrees each successive series (Figure 8, page 32). The slope of the line describing wingsweep is the inverse of the slope of the line describing aspect ratio, which is to be expected (see Figure 9, page 33, for evolution of aspect ratio).

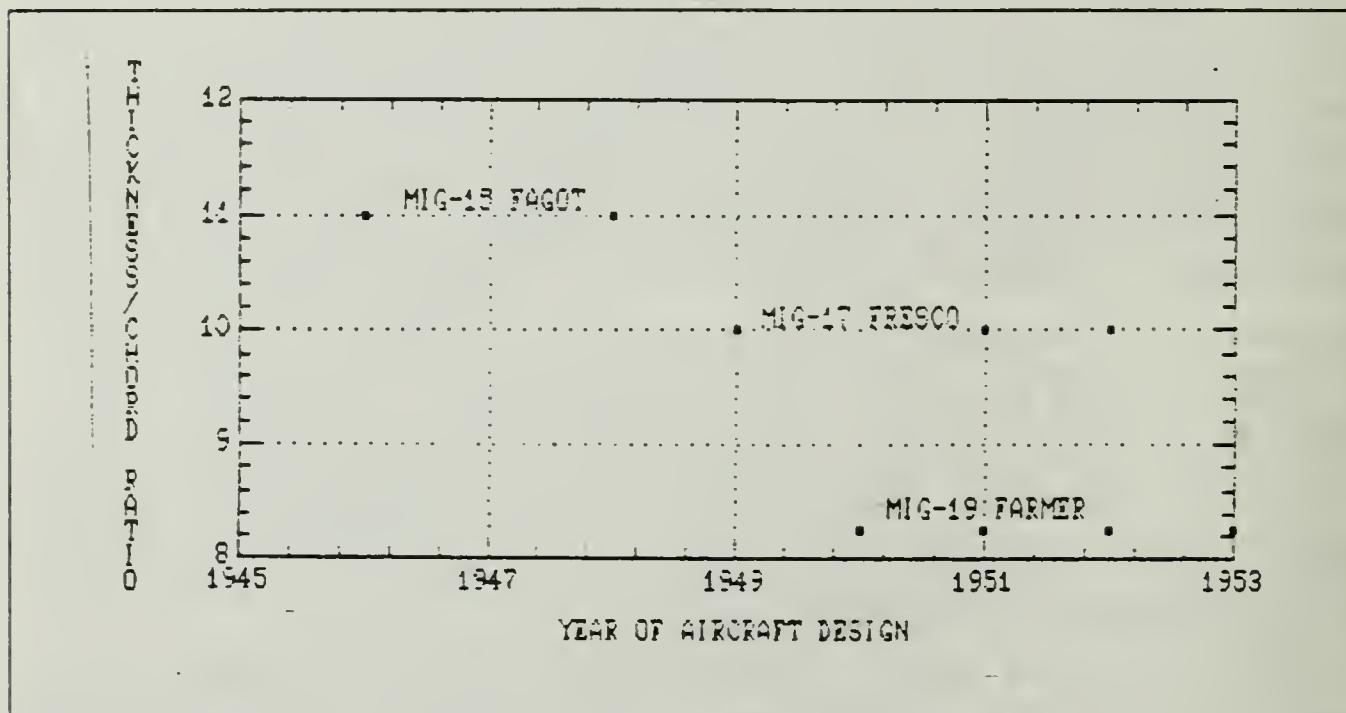


Figure 4. Evolution of Thickness/Chord Ratio (1945-1953)

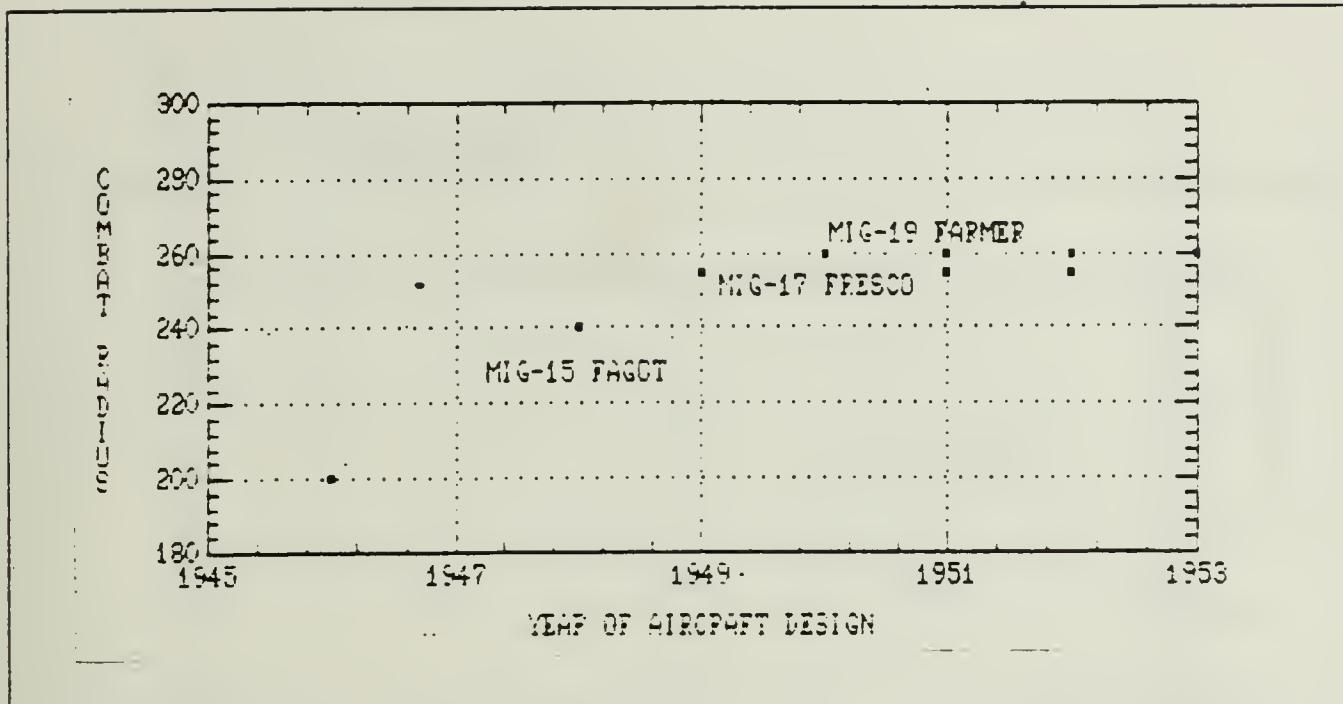


Figure 5. Evolution of Combat Radius (nm) (1945-1953)

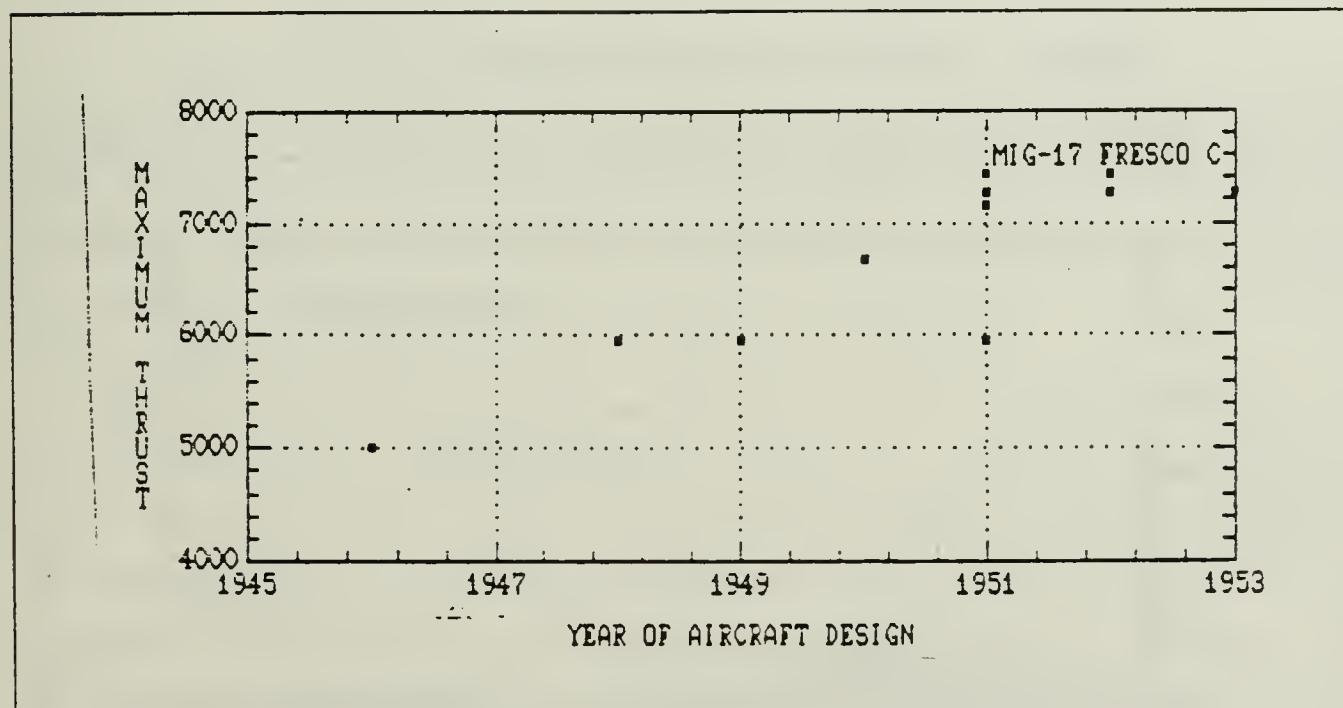


Figure 6. Evolution of Maximum Thrust (lbs) (1945-1953)

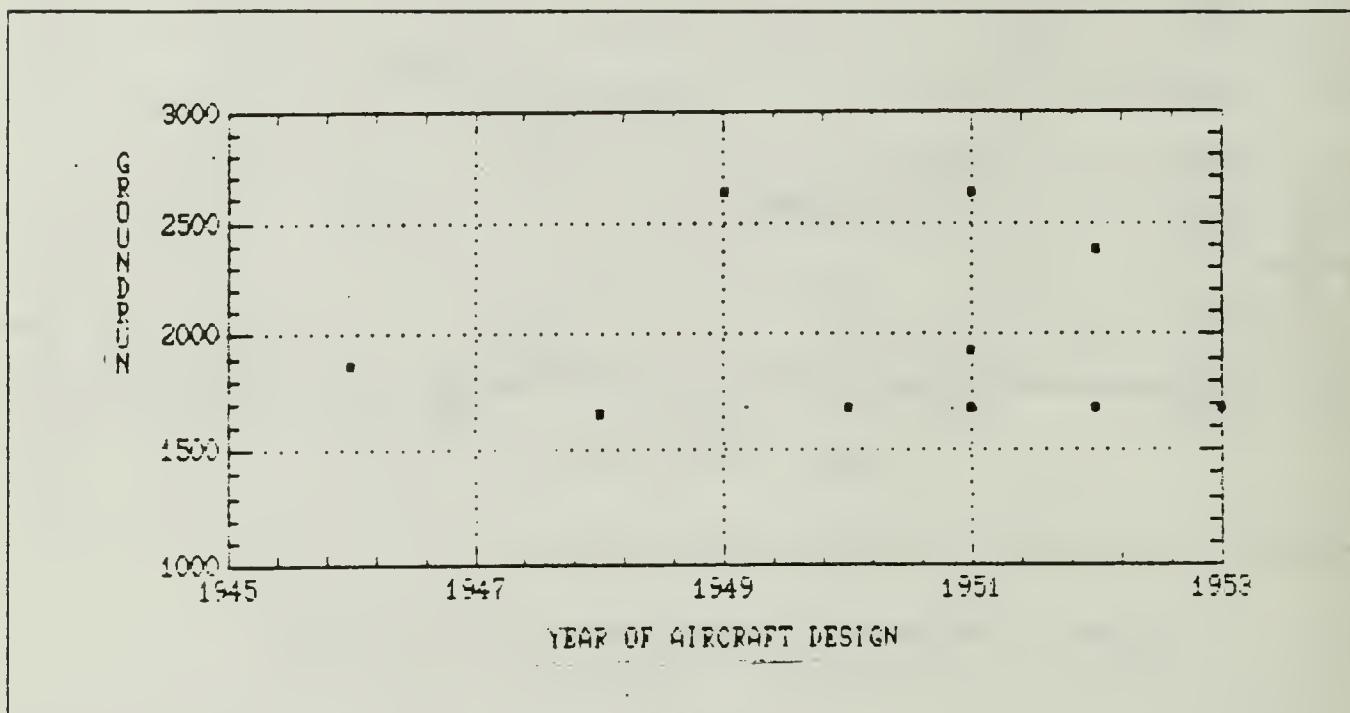


Figure 7. Evolution of Ground Run (ft) (1945-1953)

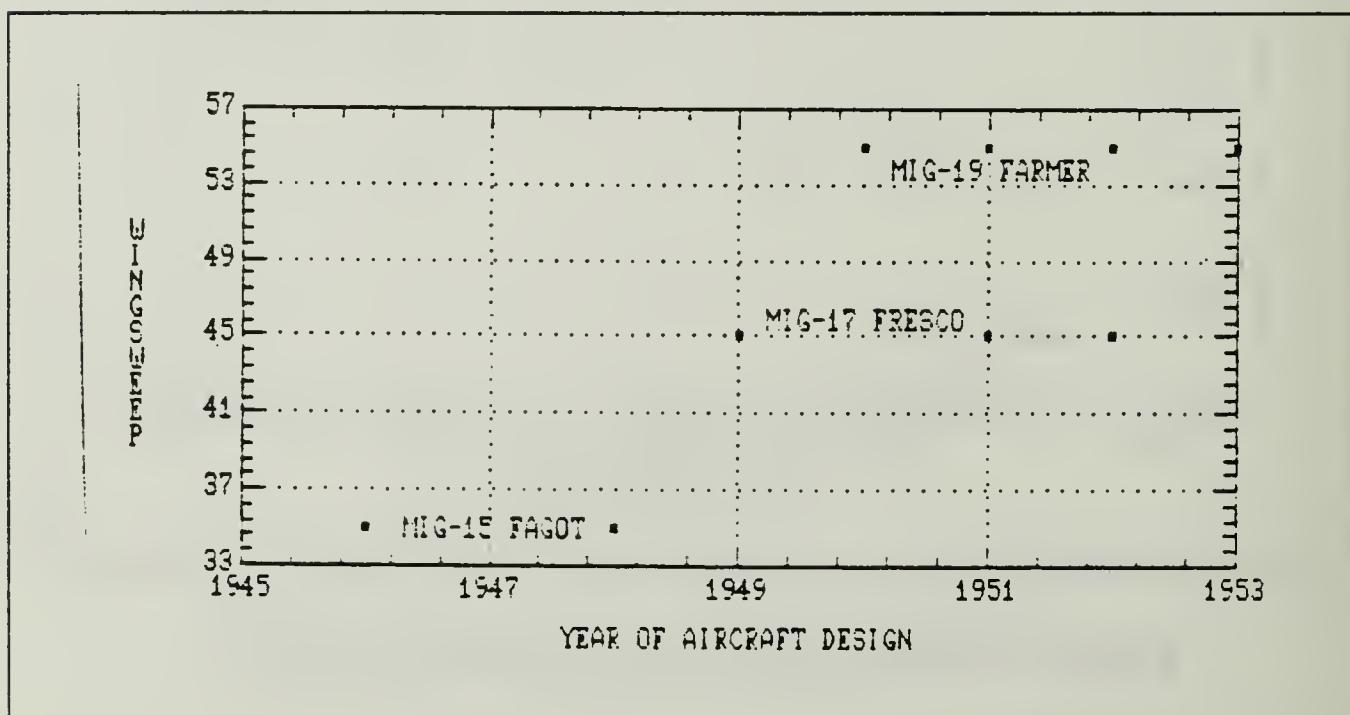


Figure 8. Evolution of Wingsweep (degrees) (1945-1953)

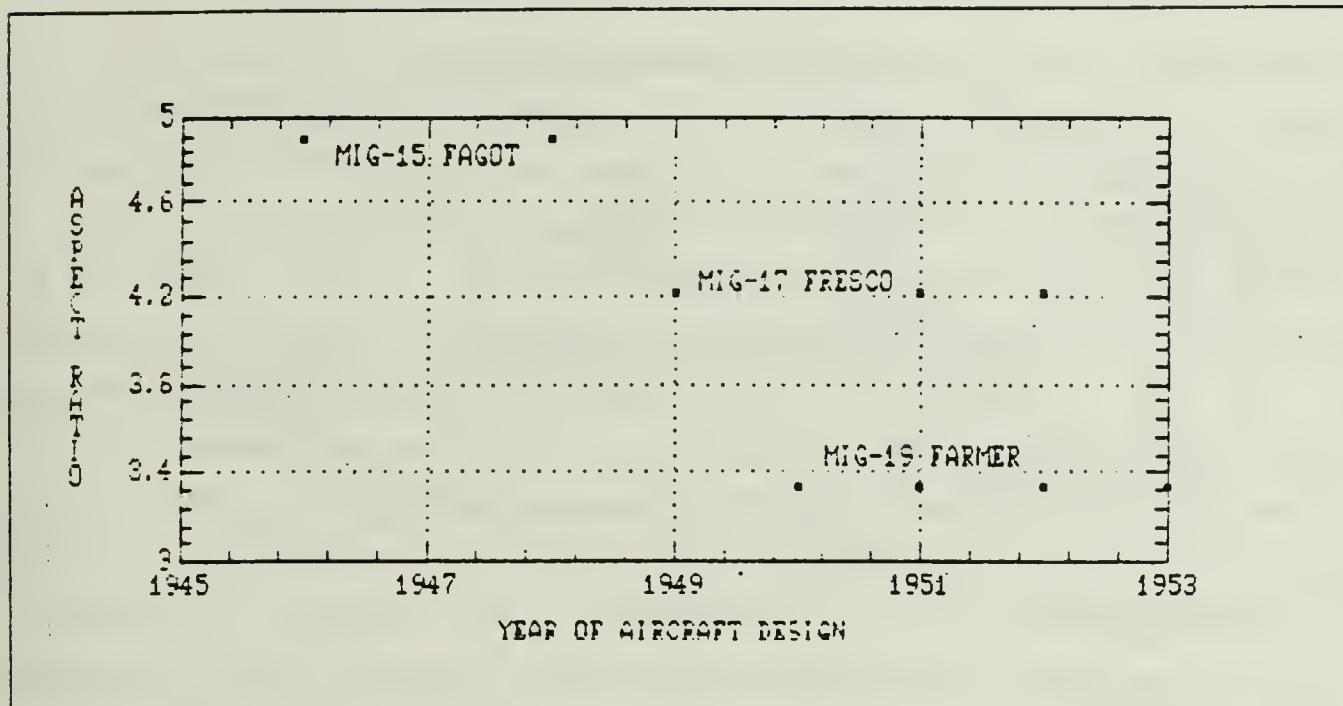


Figure 9. Evolution of Aspect Ratio (1945-1953)

The significant design changes of the 1945-1953 period are generally associated with the wing: increasing its sweep angle, making it thinner, and decreasing the aspect ratio. These changes were aimed at making the aircraft fly at higher speeds. Figure 10 (next page) aggregates the most interesting of these characteristics in their evolution. The right lower rear corner of the box represents characteristics of low, slow flight. The left upper front corner was clearly the goal from 1945-1953.

This is an interesting depiction because the evolution of design in 1945-1953 runs counter to the avowed Soviet employment concept for aircraft in that time period (about which more later). Stalin's "five permanent operating principles" emphasized the World War II-type of operation as being the model for any future conflict. Soviet air assets in WW II were used almost exclusively in support of ground operations. The vast majority of sorties were of the ground-attack type; targets were on the battlefield or located closely beyond the forward edge of the battle area (FEBA). Aircraft were deployed close to the front, where they would be better able to respond on short notice to tasking from the combined arms commander.

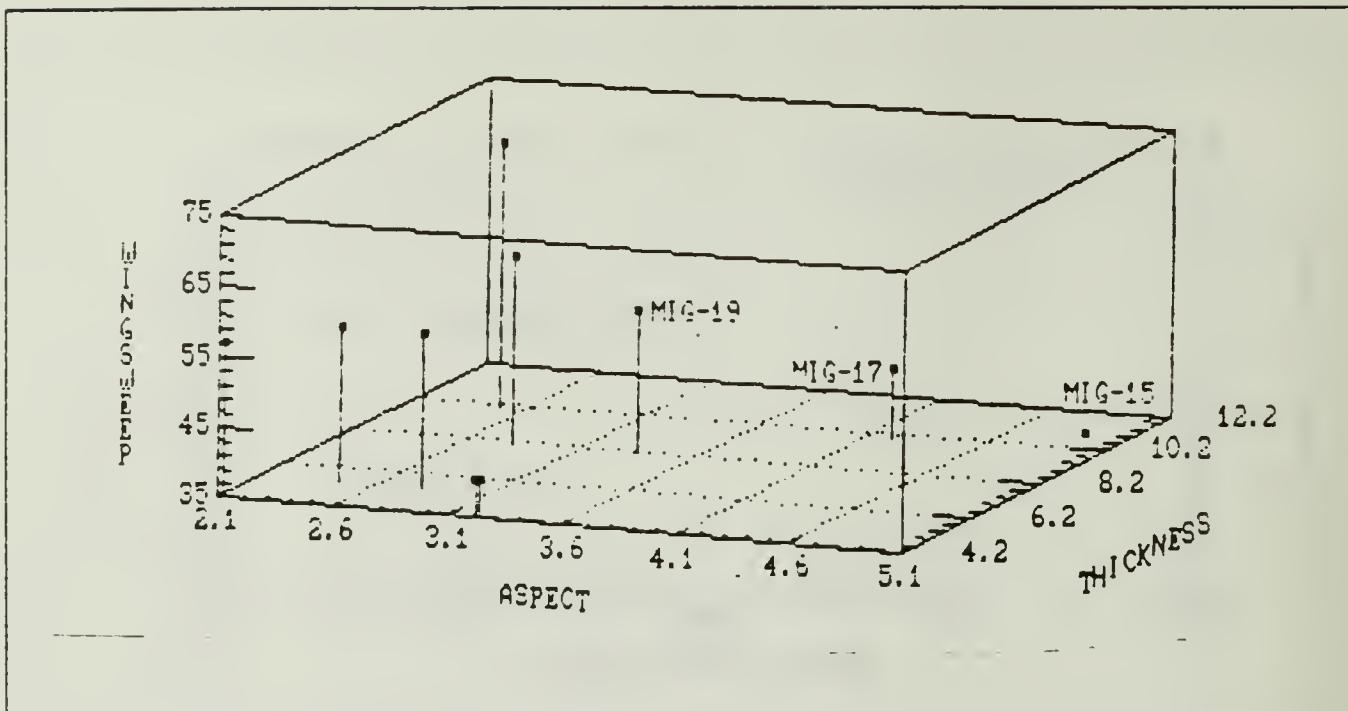


Figure 10. The Trend Toward Supersonic Flight

One of the requirements for ground support aircraft is that the pilot should be able to find his targets; in particular this means that it should be possible to distinguish friendly from enemy forces: This is very hard to do at high speed or high altitude. The ideal platform for ground attack missions is one that is low and slow. This combination of characteristics allows the pilot to acquire his targets and eases the problems of coordination between forward air controllers (FACs) and ground attack aircraft.

This is clearly not the trend of aircraft design in the Stalinist period. It is clear that the MIG OKB was designing air defense fighters that could fly higher and faster throughout the 1945-1953 period. It was in the areas of swept wings and afterburning turbojets that the biggest technological advances were being made in the period. It seems reasonable, therefore, to advance the proposition that despite the avowed employment concept for Soviet air forces in the immediate postwar period, the newly-available German technology found its way into applications not previously demanded by doctrinal requirements.

#### B. 1954-1964, A CHANGE IN EMPHASIS

Around 1953-1954, the MIG OKB developed the basic concept for the MIG-21-FISHBED. Gunston says that stipulated features included ability to carry

limited all-weather radar and AAMs with secondary guns and bombs, to operate under RSIU (Markham) secure ground control, and to have highest possible flight . . . range was discounted.<sup>43</sup> The MIG-21 was developed with two different wing planforms--one was a swept-wing identical to the MIG-19 and the other was a pure delta wing, which was the design MIG later adopted. The MIG-21's thinner wing section, sharper leading edge, and smaller aspect ratio continued the trend established 1945-1953 toward aircraft with higher flight speeds (see Figures 11 and 12, next page).

This evolution naturally led to a delta wing.<sup>44</sup> The FISHBED'S wing design, combined with a newly-designed engine, gave the aircraft a higher maximum speed at altitude than its predecessors (see Figure 13) The scatterplot in Figure 14 shows not only the increase in maximum Mach at altitude for the MIG-21 FISHBED but also for the MIG-25 FOXBAT (Figures 13 and 14 on page 37).

The FOXBAT was designed as a single-mission aircraft to counter the proposed US XB-70 supersonic bomber. That the FOXBAT was built anyway when the B-70 was cancelled is a confirmation of the thesis that a new weapon system than can be built will be built (a mechanistic version of the "technological imperative" model). Gunston says that the FOXBAT's design "owed much to (the) A-5 Vigilante;" that the aircraft's "high wing and wide boxy fuselage mainly comprising inlet ducts and engines" was "pioneered by Vigilante."<sup>45</sup> The Foxbat was never designed to engage in air-to-air combat with other fighters, but rather as a "straight-line" interceptor for high-altitude applications and fairly long range. When the XB-70 was cancelled, the FOXBAT was purchased primarily as a long-range, high-speed, high-altitude reconnaissance platform. The FOXBAT's wing loading is indicative of its mission (see Figure 15, page 38). In general, low wing loading is desirable for air-to-air combat, while the opposite is desirable for a straight-line air defense interceptor. Good cruise efficiency requires high wingloading values.

The MIG-23 FLOGGER was designed in approximately 1963. Its most immediately recognizable feature is its variable-geometry wing. The variable-geometry wing (VGW), or "swing-wing", was "so similar to the NASA/GD (General Dynamics)

---

<sup>43</sup>Gunston, *Aircraft*, p. 180.

<sup>44</sup>Francis J. Hale, *Introduction to Aircraft Performance Selection, and Design* (New York: John Wiley & Sons, 1984), p. 17.

<sup>45</sup>Gunston, *Aircraft*, p. 190 and Bill Gunston, *Modern Air Combat* (London: Salamander Books Ltd, 1983), p. 132.

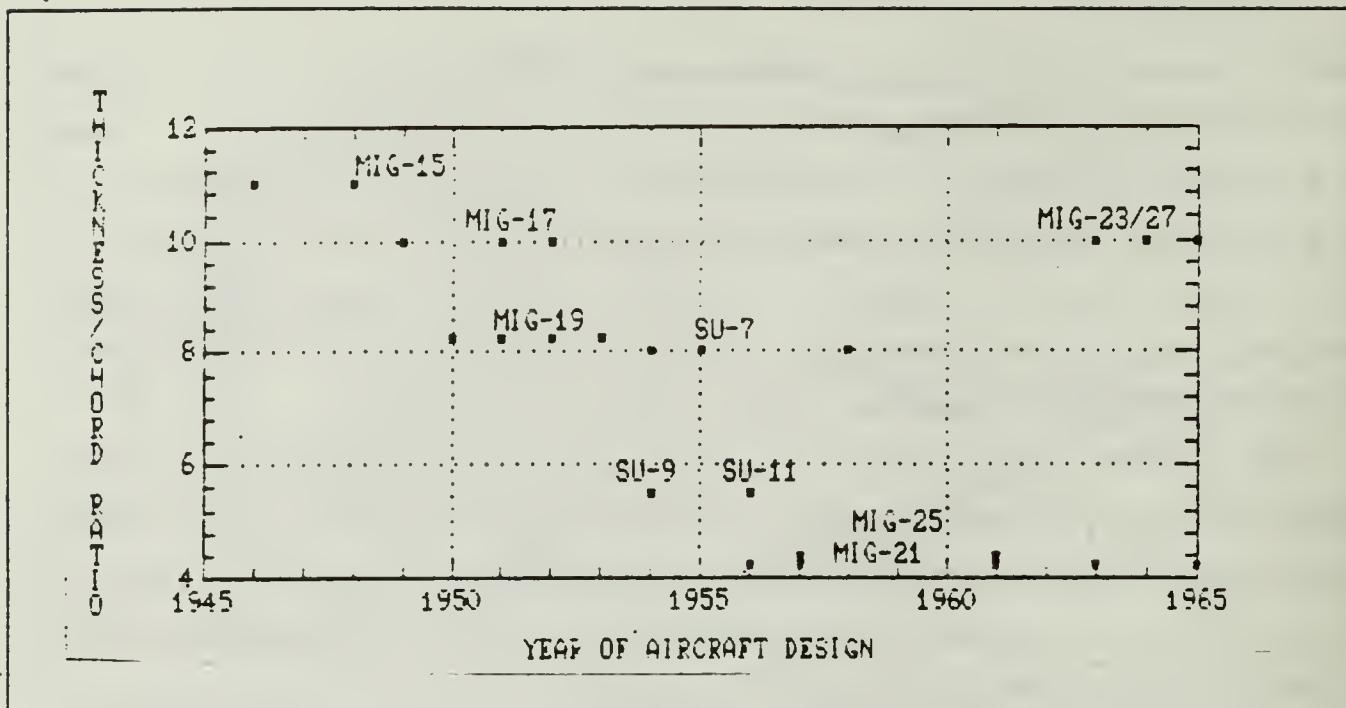


Figure 11. Evolution of Thickness/Chord Ratio (1945-1965)

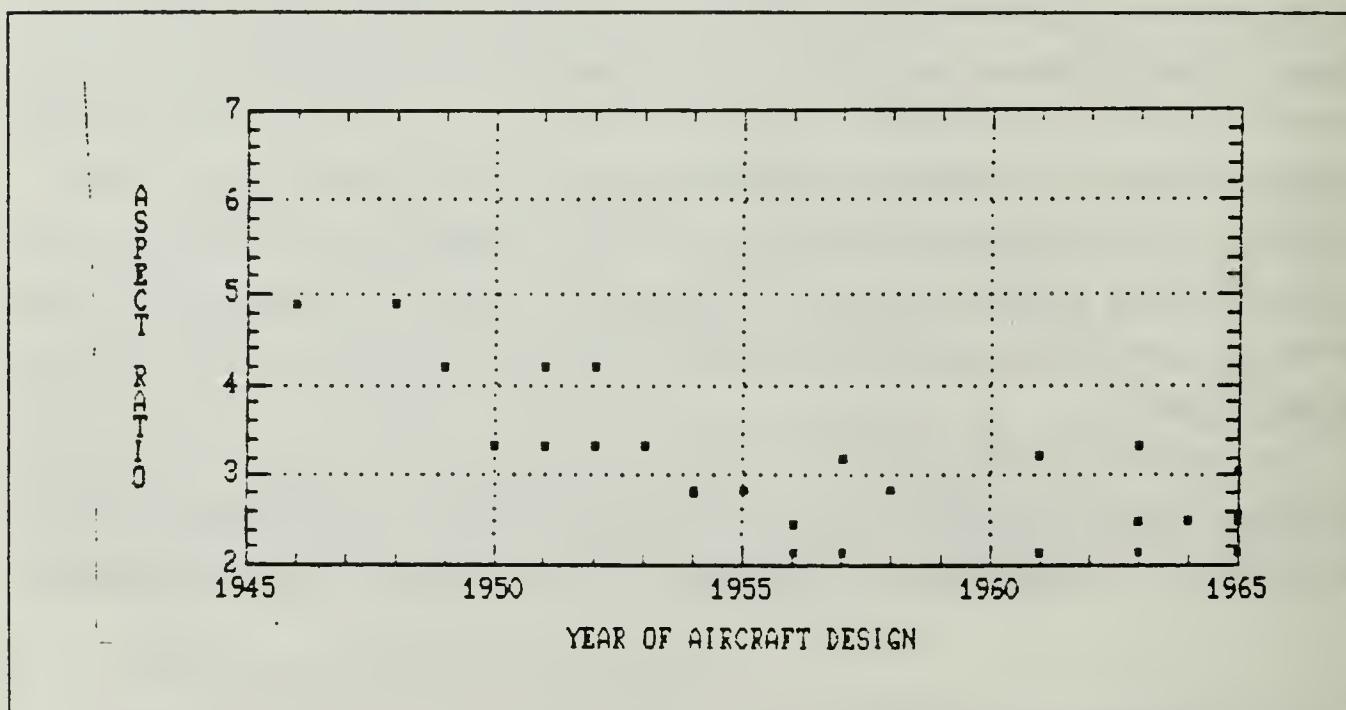
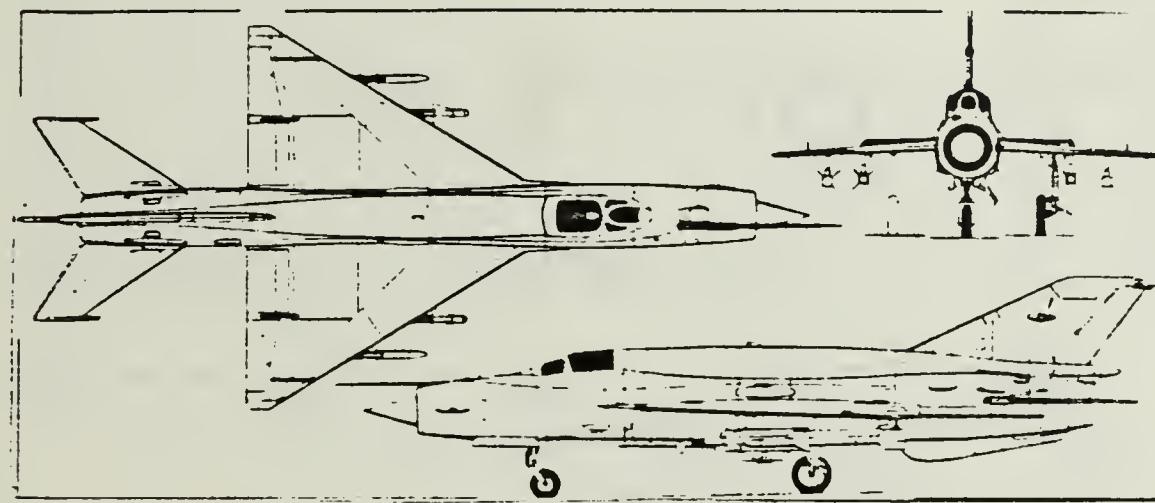


Figure 12. Evolution of Aspect Ratio (1945-1965)



Source: *Janes All the World's Aircraft 1980-1981*, p. 192.

Figure 13. MiG-21 FISHBED

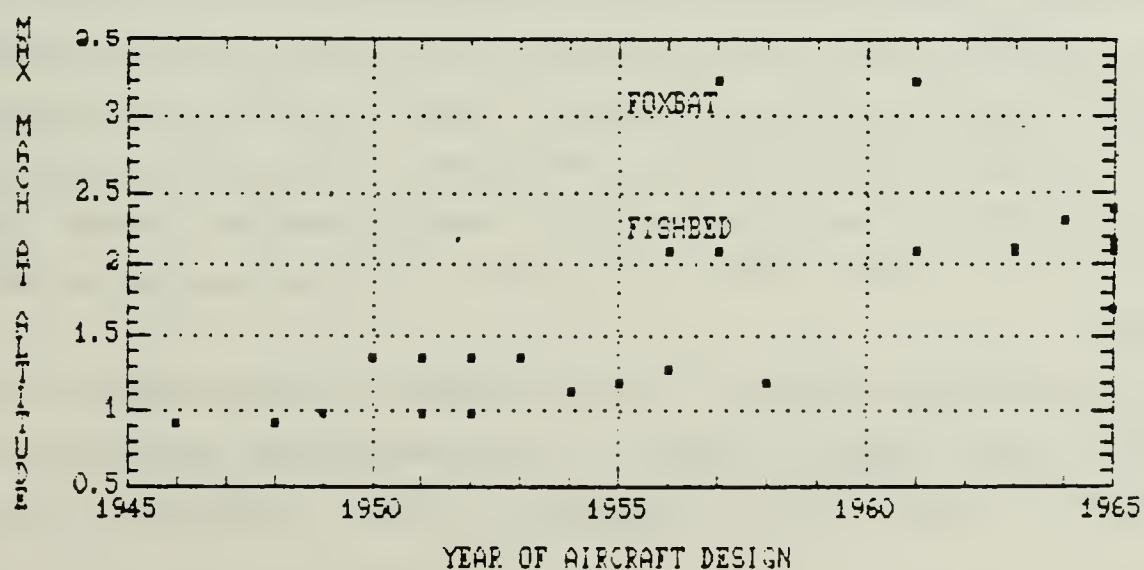


Figure 14. Evolution of Maximum Mach at Altitude

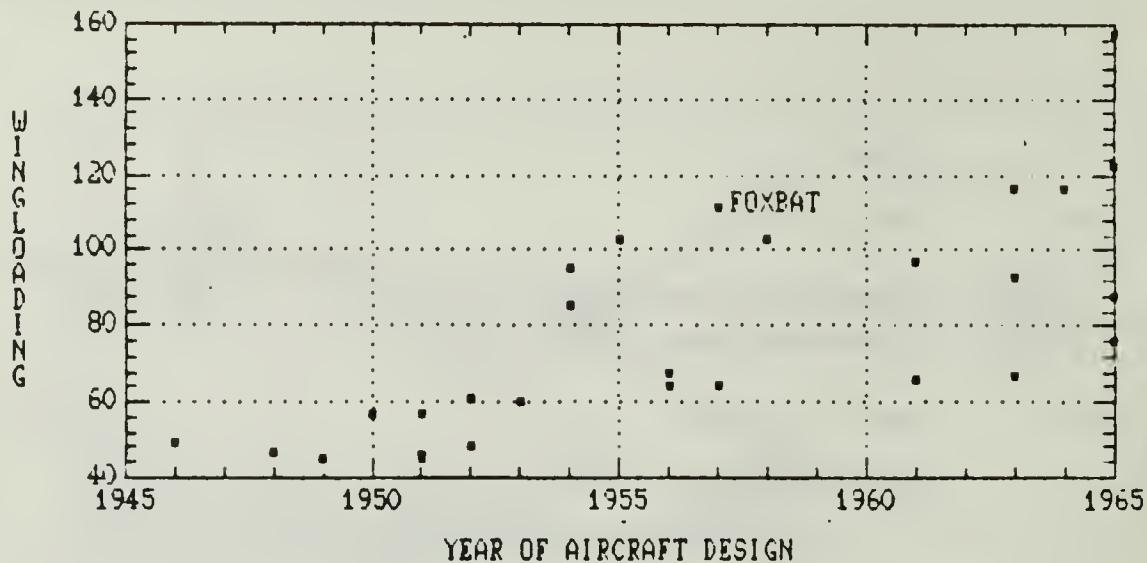


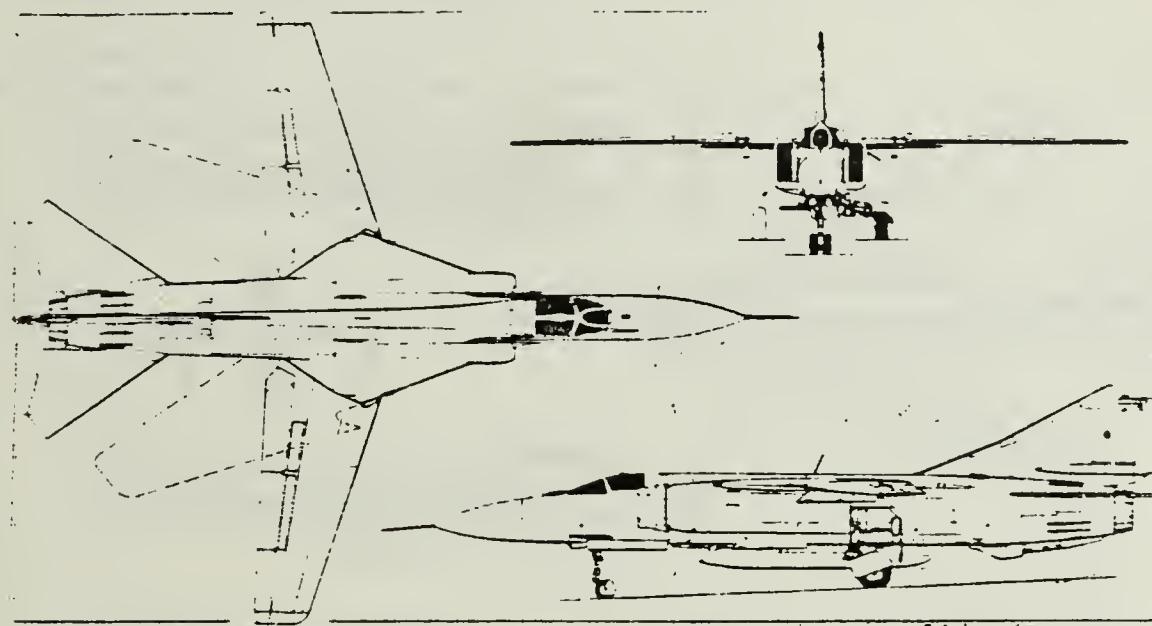
Figure 15. Evolution of Wingloading (1945-1965)

acrodynamics of (the) F-111 it was probably plagiarized.<sup>46</sup> That may be so, but the fact remains that the Soviets apparently had their reasons for going with the VGW design. One, and probably the most likely, is that the designer faces a genuine dilemma in determining an aircraft's wing sweep--a high sweep with low aspect ratio is necessary for high speed, while a low sweep with high aspect ratio is required for good low speed performance.<sup>47</sup> If the conflicting mission requirements of the Khrushchev period could not be reconciled (or just as likely, anticipated by the OKB) the VGW seems like an acceptable solution (see Figure 16, next page). There are other possible explanations, however, such as the desire to decrease takeoff and landing speeds (by increasing the lift-drag coefficient of the wing in the forward-swept position), or to reduce supersonic drag and delay transonic buffet and instability (with the wing in the fully-swept position).

The Khrushchev period saw the "resurrection" of the SUKHOI OKB and the acquisition of several SUKHOI designs. The first of these was the SU-7 FITTER and its variants. This aircraft was first designed in 1954 on the basis of earlier designs

<sup>46</sup>Gunston, *Aircraft of the Soviet Union*, p. 186.

<sup>47</sup>Ecland M. Nicolai, *Fundamentals of Aircraft Design*, (San Jose: METS, 1984), pp. 7-17.

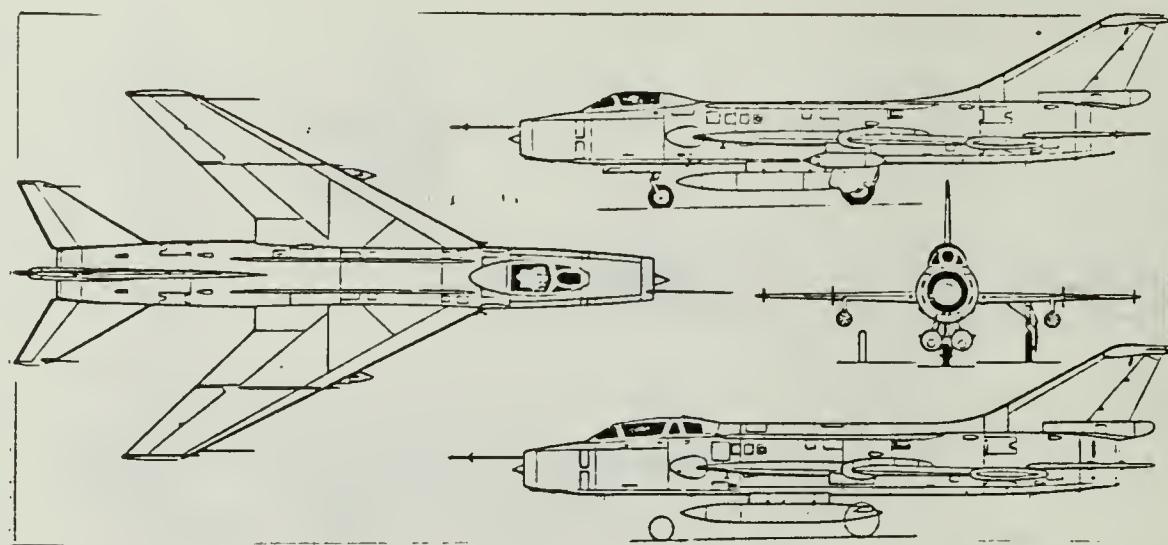


Source: *Janes All the World's Aircraft 1980-1981*, p. 195.

Figure 16. MIG-23 FLOGGER

Sukhoi had done at the Tupolev OKB. The FITTER had a very highly-swept wing (see Figure 17, next page). The 62-degree wingsweep and the FITTER's Lyulka AL-7F turbojet engine, gave it a high penetration speed. In general it can be said that the SUKHOI OKB tends to use Lyulka engines, while MIG prefers powerplants made by the Tumanskiy design bureau. Figure 18 (page 40) shows the evolution of maximum (afterburning) thrust and the generally more powerful Lyulka engines. In 1961 SUKHOI used a Tumanskiy engine for his SU-15 FLAGON, with predictable results for its relative maximum thrust.

The FITTER had some severe limitations--for example, very small internal fuel tankage. This led to the requirement for a heavy load of external fuel carriage, which made impossible any significant weapons load. Thus, the figures commonly cited for these two characteristics obscure the true capability of the aircraft: the necessity of choice between fuel and weapons was essentially a choice between an aircraft with "long legs" but little ordnance, or one with a heavy load of ordnance that could not be flown to great depth. Nevertheless, the SU-7 FITTER did have good low-level stability (what Gunston calls "docile flying qualities") and good structural integrity and



Source: *Janes All the World's Aircraft 1980-1981*, p. 204.

Figure 17. SU-7 FITTER

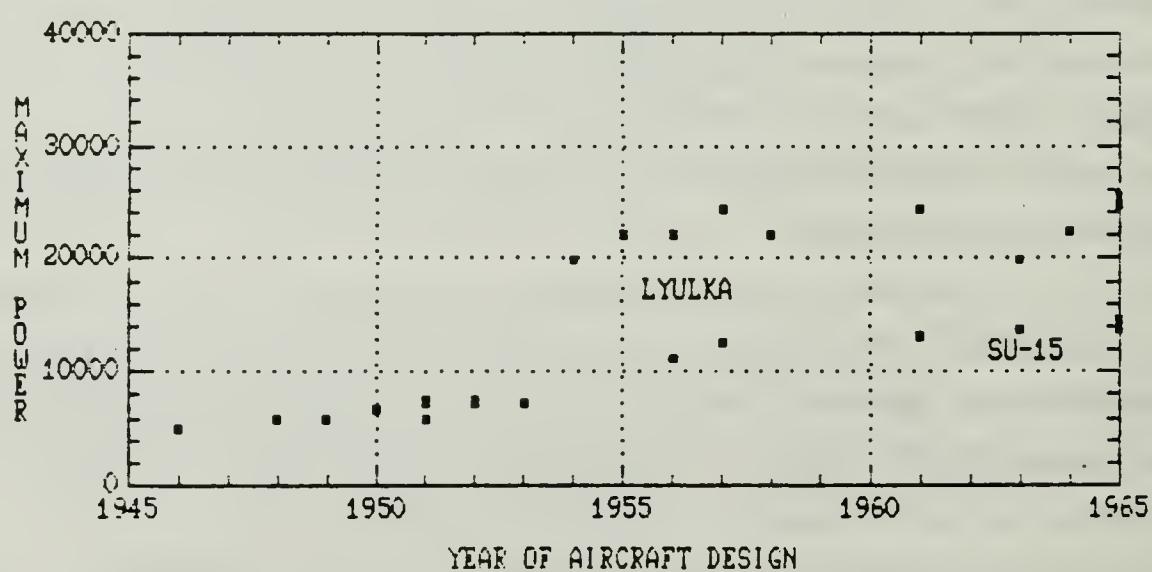


Figure 18. Evolution of Maximum Thrust (lbs) (1945-1965)

toughness. In addition, it also had a large ordnance-carrying capacity, although subject to range limitations (see Figure 19).

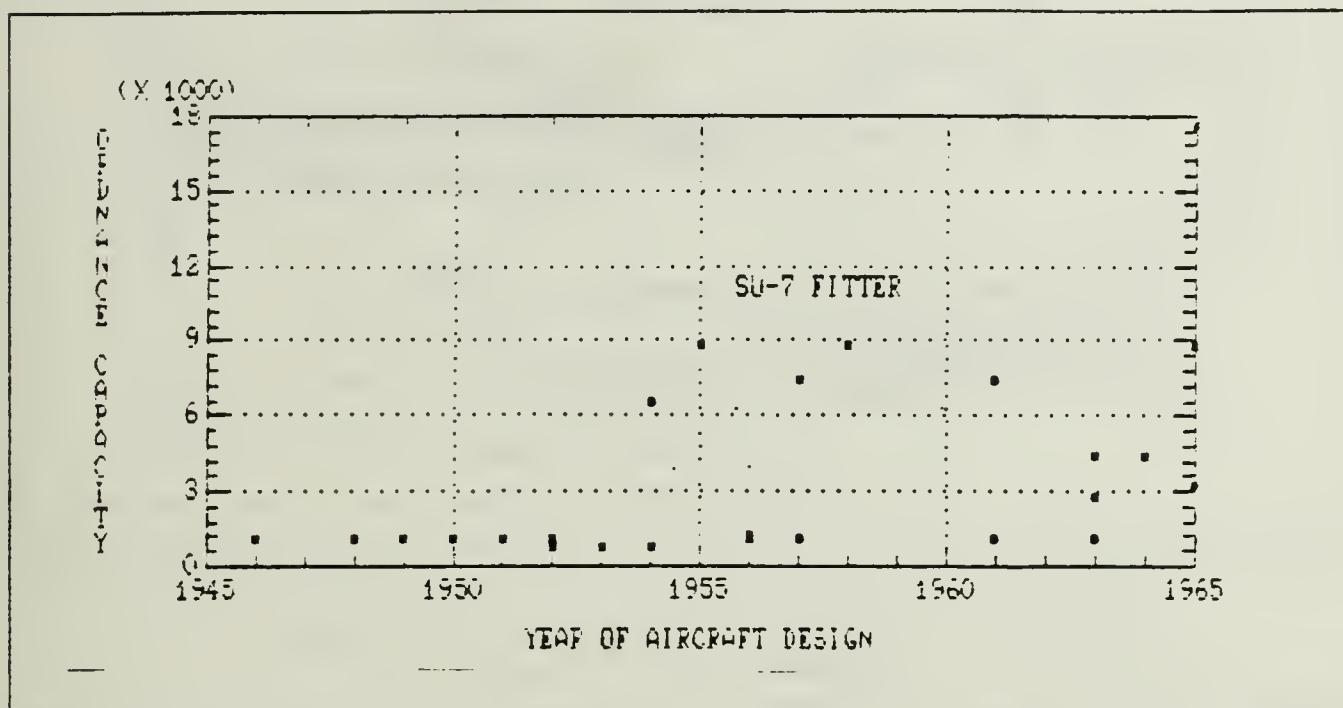


Figure 19. Evolution of Ordnance-Carrying Capacity (lbs) (1945-1965)

The FITTER's highly-swept wings and its external weapons/fuel load combined to give it a very high rotation speed and, consequently, a long ground run (almost 7,900 feet). In fact, this was true too for the other SUKHOI designs of the period (SU-9 FISHPOT B, SU-11 FISHPOT C, and the SU-15 FLAGON A; see Figure 20, next page). This tended to be true of all PVO air defense interceptors, which could count on long, high-quality runways. If these same aircraft were called upon to operate "at the front," they would have found it nearly impossible to do so from shorter, often unimproved wartime strips in the forward area. One wonders how the SU-7 FITTER could have been used at all.

The SU-9 and the SU-11 FISHPOT aircraft were based on the delta wing designs SUKHOI had worked on but rejected for the FITTER. They shared a number of features with the SU-7, such as the tail section and the fuselage (Figure 21, p. 43).

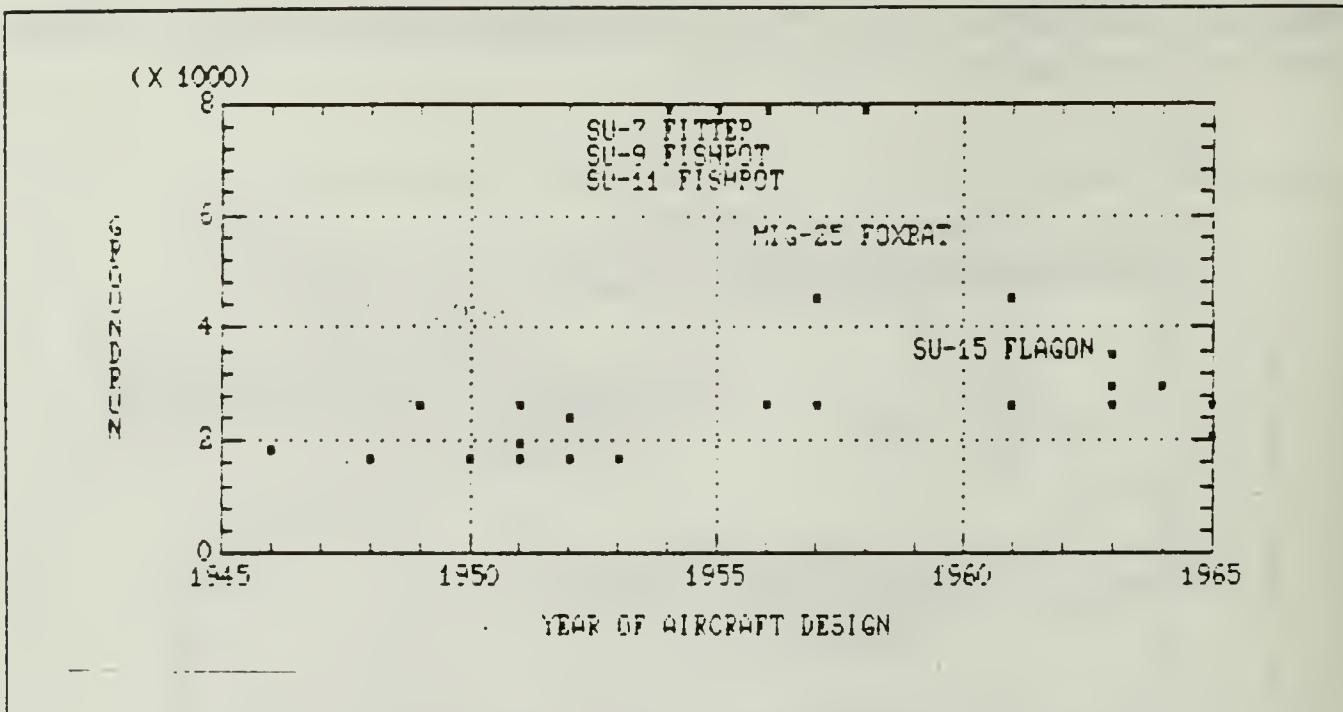
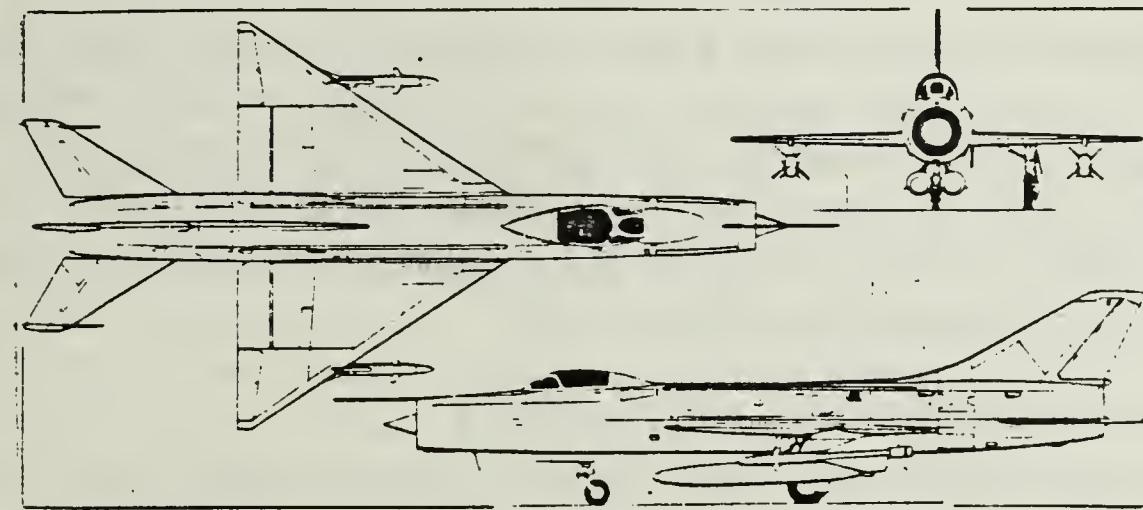


Figure 20. Evolution of Ground Run (ft) (1945-1965)

Unlike the SU-7, however, the FISHPOT aircraft were not easy to fly. Although the SU-11 had only two AAMs while the SU-9 had been equipped with four, the SU-11's missiles had a range approximately three times as great as the SU-9's and its air intercept (AI) radar was more powerful, with search and track capability about double that of its predecessor.

The SU-15 FLAGON, a version of which in September 1983 shot down a South Korean Boeing 747 passenger aircraft, was designed in approximately 1962-63. Its internal fuel capacity was increased somewhat over earlier designs, perhaps prompted by the requirement to get to distant intercept points from inland (high-quality) airfields with long runways. In general, PVO air defense interceptors had greater combat radii than Air Force (VVS) fighters (see Figure 22, next page).

To summarize fighter developments in this period, the MIG OKB continued its trend toward building faster aircraft, primarily for the air defense mission, but also for reconnaissance. MIG aircraft were also a part of the VVS inventory, but their design characteristics did not optimize them for the ground support role. After producing the MIG-25 FOXBAT to meet a threat which never developed (the XB-70), the MIG OKB began the FLOGGER series, which included a VGW design in order to accomodate a variety of requirements which could not otherwise be reconciled and to provide a measure of flexibility in employing the FLOGGER.



Source: *Janes All the World's Aircraft 1980-1981*, p. 211.

Figure 21. SU-11 FISHPOT

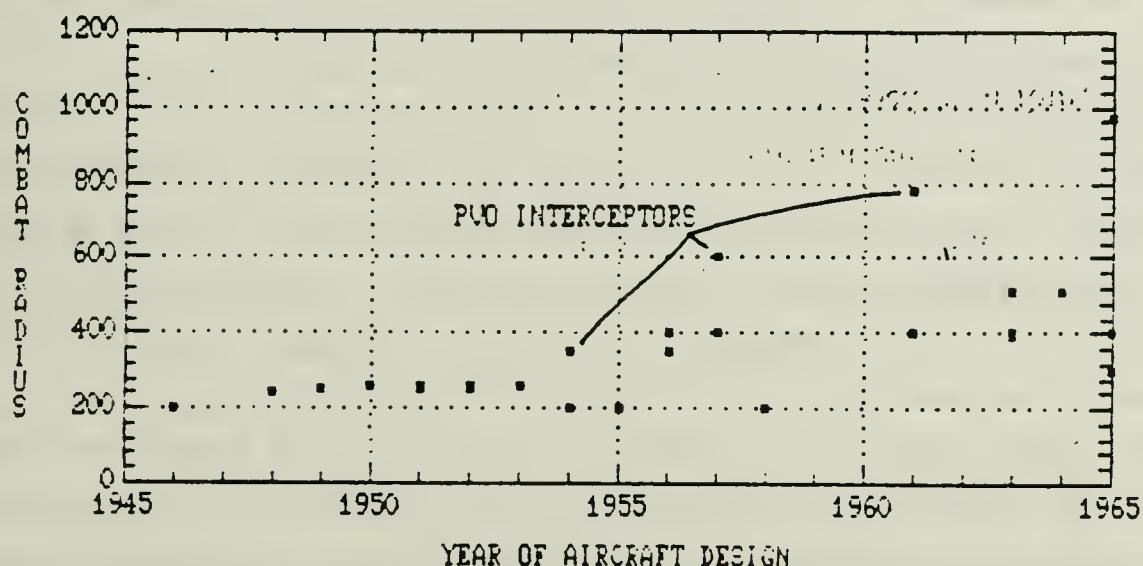


Figure 22. Evolution of Combat Radius (nm) (1945-1965)

This period also saw the first acquisitions of SUKHOI aircraft. These included the SU-7 FITTER, with an impressive ordnance-carrying capability and good low-level performance. This made it the first "dedicated" ground support/attack aircraft for the VVS in the postwar period. Its development foreshadowed the increasing VVS interest in ground attack aircraft which became evident after 1964. The SUKHOI OKB also produced several air defense interceptors for PVO.

### C. 1964-1973, THE RISE OF GROUND ATTACK

When the MIG-21 was originally produced, it was optimized for the short-range intercept mission. A product of the 1950's, it was quite limited in its avionics, navigation equipment and cockpit displays. Subsequent development sought to correct these deficiencies as well as its limited weapons and payload capacity.

The FISHBED J, and its subsequent variants, incorporated the Jay Bird AI radar, replacing the Spin Scan radar present on earlier models of the aircraft. The Jay Bird operates at a higher frequency than Spin Scan, employs a different scanning method, and has slightly better range in both search and track modes. It is part and parcel of the new weapons fit for the FISHBED in that it provides target illumination for the semi-active radar-homing version the AA-2 ATOLL AAM.<sup>48</sup>

MIG also doubled the number of wing stations to four, improving simultaneously air combat capability and ground attack potential. The addition of the pylons tripled the ground attack payload potential, and doubled the number of possible AAM's. The FISHBED H, the reconnaissance variant, is basically similar to the FISHBED J but carries an external pod with forward-facing or oblique cameras, infrared sensors, and electronic countermeasures (ECM) equipment.

Other changes made to the FISHBED in this time period were in the area of propulsion. The progressive improvements to the Tumanskiy R-11 turbojet included enlarged afterburners and provisions for flap blowing.<sup>49</sup> The R-13 engine that replaced the R-11 has an advanced afterburner, a new compressor with greater airflow capacity

---

<sup>48</sup>This missile was originally an infrared-guided AAM.

<sup>49</sup>Flap blowing helps to increase the coefficient of lift, in turn enabling an aircraft to take off and land at lower speeds (shorter ground run). Flap blowing energizes the airflow on the wing; it is done by extracting high pressure air from the last stage of the engine compressor and piping it to slots just in front of the wing trailing edge or behind the leading edge flaps. It reenergizes the boundary layer (the layer of air next to the wing's skin), increasing the coefficient of lift. See Charles E. Dole, *Flight Theory and Aerodynamics* (New York: John Wiley & Sons, 1981), pp. 142-145.

(these provide for greater thrust), and it is lighter in weight. Finally, the R-25 has an advanced, high-pressure ratio compressor with a significantly lower specific fuel consumption than earlier powerplants.<sup>50</sup>

SUKHOI temporarily departed from the long-standing association of his design bureau with the Lyulka engine when the SU-15 was designed. He chose to use the Tumanskiy R-11 engine found in the early FISHBED aircraft, and later switched to the upgraded R-13, just as had the MIG OKB. In addition to new engines, the FLAGON E and FLAGON F models have a slightly redesigned wing; they have a larger span and outer portion of reduced sweep, which creates a "kink" in the wing's leading edge (Figure 23, next page). This kink is a vortex inducer, performing the same kind of boundary layer control function provided for in the FISHBED by flap blowing. The FLAGON makes use of both devices, suggesting increased attention on the part of SUKHOI to the limitations imposed by the demands of an aircraft with a rotation speed of approximately 215 knots and a takeoff ground run of nearly 8,000 feet.

The new FLAGON aircraft also have a new AI radar; the Twin Scan, which replaces the older Skip Spin. Open source information is hard to find on the Twin Scan but it is probably more powerful than its predecessor and may have enhanced ECM/ECCM (electronic counter-countermeasures) features.

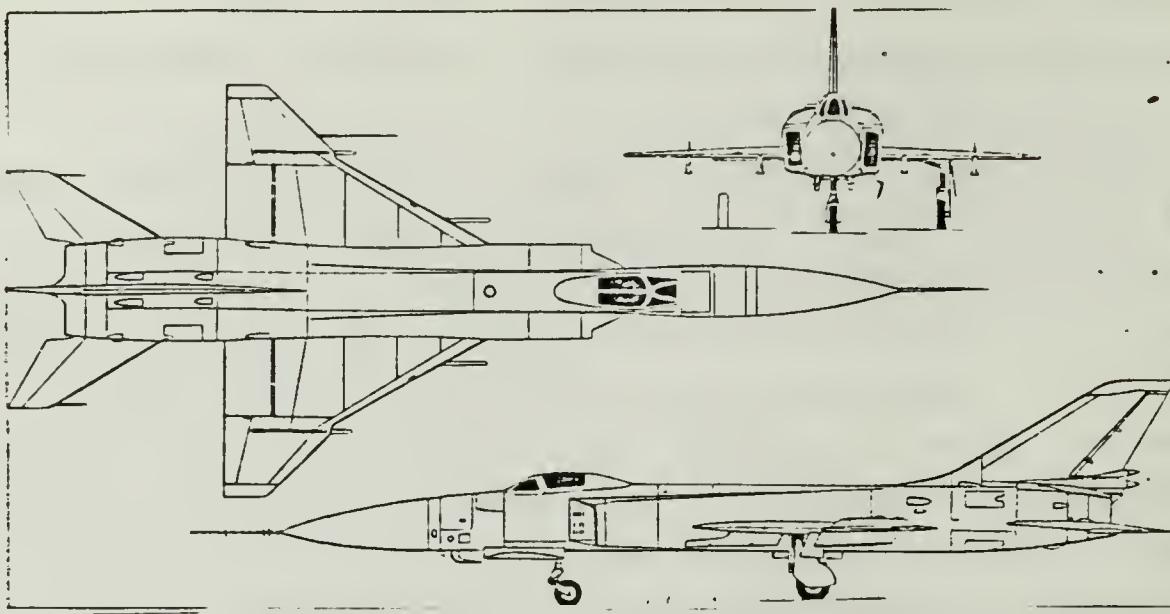
In the ground attack arena, MIG determined around 1965 that the original design for the MIG-23 FLOGGER was not really adequate for the ground attack mission, and began development of a follow-on making use of the basic air defense FLOGGER airframe. The FLOGGER D has no AI radar but a broad, flat, downsloping nose containing a variety of sensors for the air-to-ground mission. The aircraft also includes armored side panels, a new six-barrel gun and a new weapons and avionics fit (see Figure 24, page 47).

The FLOGGER D has a doppler navigation radar and a laser designator in its nose. There are bomb racks on the fuselage, in addition to five pylons, which may be plumbed for fuel carriage. The aircraft is capable of carrying twice as much ordnance as its air-to-air cousin. Commensurate with its ground attack role are fixed air inlets and engine nozzle. Finally, the FLOGGER has an ECM jammer pod on the wing leading edge, and a head-up display (HUD).<sup>51</sup>

---

<sup>50</sup> *Janes All the World's Aircraft*, p. 845.

<sup>51</sup> A HUD is a pane of glass, on which is projected such necessary flight data symbology as speed, heading, altitude, weapon status, etc. The data is generated



Source: Gunston, *Aircraft of the Soviet Union*, p. 276.

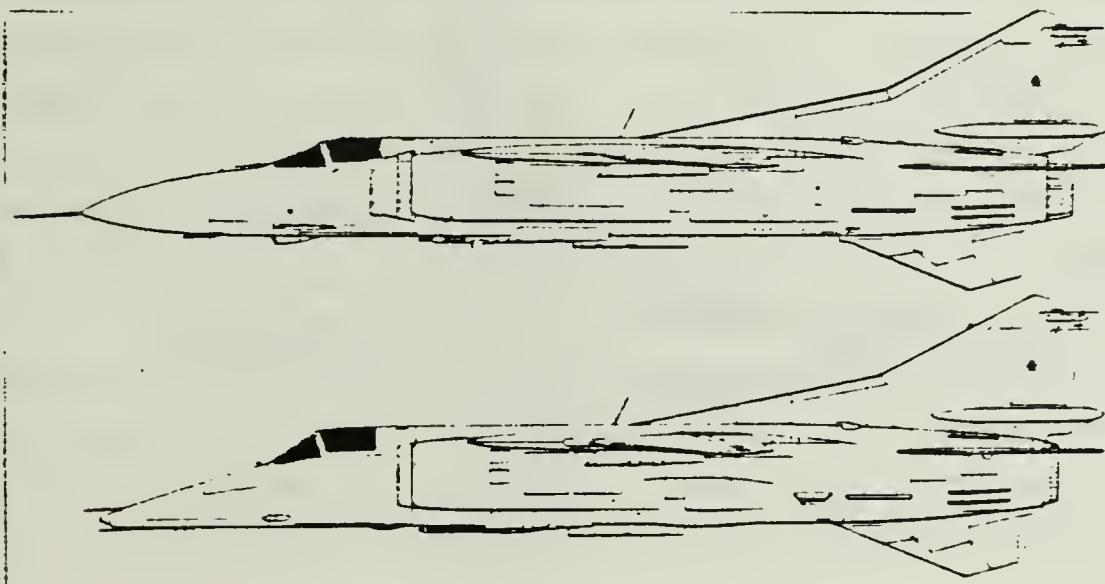
Figure 23. SU-15 FLAGON E/F

Another new ground attack aircraft in this time period was SUKHOI's SU-17 FITTER C and FITTER D. These designs attempted to retain what was good in the original SU-7 FITTER, and improve what was detrimental to performance. To this end SUKHOI made a variety of changes, the first and most obvious being the addition of VGW. This increased the aircraft's lift coefficient, reducing rotation and approach speeds by about 40 knots, and decreasing the groundrun by about 5,800 ft. Turn radius was halved and control forces were reduced significantly. Thus, Gunston says that the SU-17's

in-flight agility, range and field length have all benefited [also] from the new Lyulka engine, which though more powerful actually burns fuel rather less rapidly than the [earlier] AL-7F-1; and there has been a modest increase in fuel capacity.<sup>52</sup>

electronically and focused at infinity. This allows the pilot to keep looking outside the cockpit, which is safer and more effective in combat.

<sup>52</sup>Gunston, *Modern Air Combat*, p. 160.



Source: *Janes All the World's Aircraft 1980-1981*, p. 194.

Figure 24. Comparison of MIG-23 (top) and MIG-27 (bottom)

Eight highly-rated pylons give the aircraft a good ordnance capacity; four of the stations are plumbed for fuel tankage and go a long way toward increasing combat radius. A wide variety of weapons can be carried by the FITTER; including all kinds of general purpose bombs, rockets of various sizes, ASMs and, like nearly all other ground attack aircraft in the VVS, nuclear weapons. Avionics include a navigation radar, laser designator, HUD, ECM and, as do most Soviet fighters, a radar warning receiver (RWR).

The final aircraft considered in this section is the SU-24 FENCER, a

totally new design owning no direct relationship to any existing type from the same OKB. Indeed, it owes more to the American F-111 than to any<sup>53</sup> other single type, even to the almost certainly mistaken use of side-by-side seats.

<sup>53</sup> Gunston, *Modern Air Combat*, p. 162.

The SU-24 has a tremendous ordnance-carrying capacity; approximately 18,000 lbs. It also has very "long legs," a multipurpose radar, laser designator, full ECM suite, a multisensor weapon-delivery system, and a full set of leading- and trailing-edge slats and flaps for excellent control and stability. If the FENCER is anything like the European Panavia Tornado--and there is good reason to suspect that at least many of its components are similar--it can operate over a wide range of flight regimes with smooth and fatigue-free low-level missions. (See Figure 25, next page).<sup>54</sup>

The evolution of Soviet fighter technology in the 1964-1973 period can best be characterized by pointing to the growth in recce, ECM, and ordnance-carrying capacity. In the area of reconnaissance, the FISHBED H was deployed with a wide variety of sensors, including a real-time television downlink. This is one of

various technical means designed for speeding up the processing and transmission of reconnaissance<sup>55</sup> information to the interested parties directly from on board the aircraft in flight.

When the Soviets developed the ability to acquire targets beyond the FEBA and deep in the enemy's rear area, it became possible for them to consider deeper attacks than had previously been the case. As will be shown later, this is exactly what they did, despite the enormous relative cost of transmitting reconnaissance data electronically via a data link compared to flying a sensor over enemy territory, imaging targets, and returning to base for processing, analysis and subsequent dissemination.

In the area of ECM, the Soviet aircraft of this period are equipped with 360-degree RWR coverage. These are typically the simplest and least expensive (in terms of the burden imposed on aircraft performance) of ECM devices. By means of

---

<sup>54</sup>In 1984 Manfred Rotsch (the German head of the Planning Department of Messerschmitt-Bolkow-Blohm (MBB), one of the three participants in the Panavia Tornado program) was arrested for passing to the Soviets critical information about the Tornado. *The Washington Post* has reported that "Rotsch has probably betrayed the complete plans for the Tornado fighter plane" and that "because of the kind of information compromised, the Rotsch case surpasses in importance that of Gunter Guillaume, a close advisor to then-chancellor Willy Brandt, whose unmasking as a spy caused Brandt to resign in 1974." William Drozdiak, "Soviets Seen Escalating Drive for West's Industrial Secrets," *The Washington Post*, 24 October 1984, p. A26. The US Department of Defense has also publicly cited this case as particularly serious and adds that Rotsch had operated as a spy from 1967-1984. See *Soviet Acquisition of Military Significant Western Technology: An Update* (Washington, D.C.: Department of Defense, 1985), p. 20.

<sup>55</sup>Marshal of Aviation S. Krasovskiy, "Trends in the Use of Aircraft in a Nuclear War," *Voennaya Mysl'*, March 1967, in *Selected Readings From 'Military Thought,' 1963-1973* (Washington, D.C.: US Government Printing Office, 1982), p. 152.

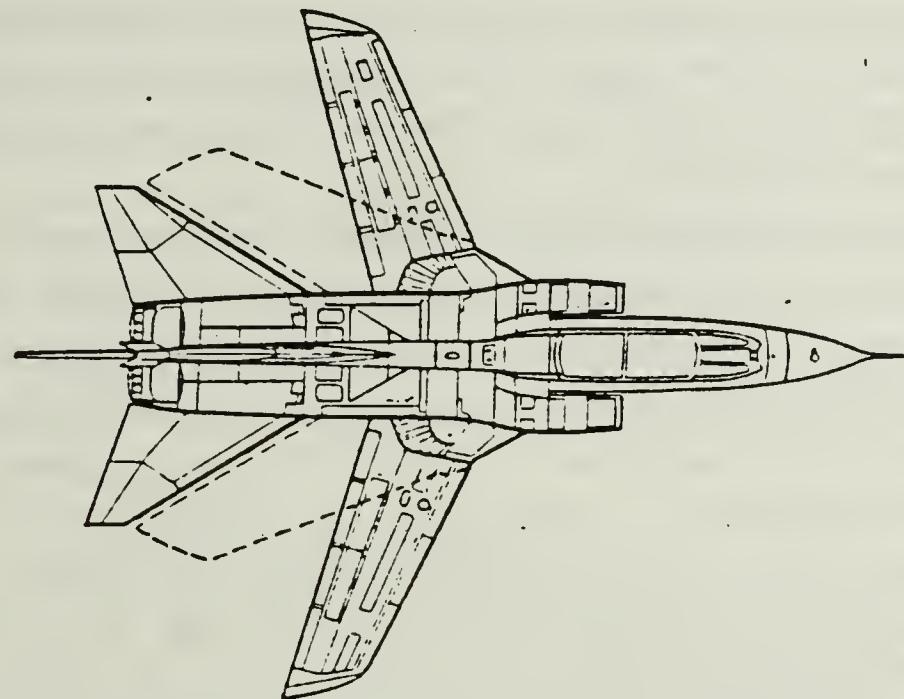
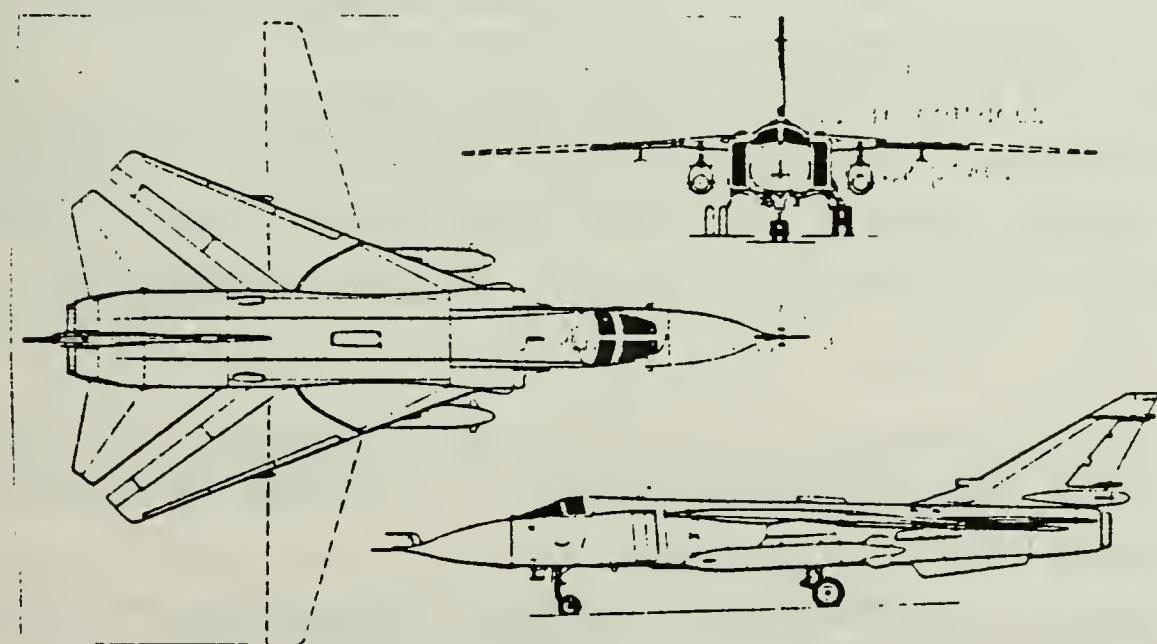


Рис. 17. Истребитель-бомбардировщик «Торнадо»

Translation: Tornado fighter-bomber

Source: A. N. Ponamarev, *Aviatsiya Nastoyashchego I Budushchego* (Moscow: Voenizdat, 1984), p. 80.



Source: *Janes All the World's Aircraft, 1985-1986*, p. 251.

Figure 25. Comparison of Panavia TORNADO and SU-24 FENCER

flashing lights on a cockpit display or an audible tone, the RWR notifies the pilot that a hostile radar has established a track.<sup>56</sup> The target aircraft can then undertake some form of countermeasure. This can range from brute force "noise jamming" to very sophisticated types of deception.

In noise jamming the target aircraft transmits a noise-like signal on the same frequency band at which the enemy radars were operating. In this case, the noise-like signal strength would exceed that of the weaker target echo-return, whiting out a sizable portion of the enemy's radar display. A drawback to noise jamming is that it dissipates power; for an aircraft it may be difficult to "outshout" a ground-based radar facility. Noise jamming can be spread across several bandwidths (barrage noise jamming) or concentrated on one known threat frequency (spot jamming). This is the far more efficient form of jamming but it requires knowledge of the enemy's radar frequencies. Furthermore, even when spot jamming can be employed, it is seldom directional in nature; the energy is radiated in all directions, wasting 99.9 percent.<sup>57</sup>

This has focused attention on "power management," by which ECM resources should be more integrated, automated, effective and efficient, by deploying the best jamming strategy for the particular situation at hand.<sup>58</sup> Power management techniques are used on the US F-15 and F-111. The Soviets are well aware of the importance of these ECM techniques and their countermeasures.<sup>59</sup>

One type of deception involves beam-splitting, which measures the point of the strongest echo-return corresponding to the center of the radar beam. The deception jammer (repeater) retransmits the received radar pulse with power inversely proportional to that with which it was received. This introduces severe azimuth and

---

<sup>56</sup>"Typically an RWR is arranged to warn that a track has been established whenever a high PRF (pulse repetition frequency) . . . is sustained for a preselected period." Gunston, *Modern Air Combat*, p. 52.

<sup>57</sup>Gunston, *Modern Air Combat*, p. 54.

<sup>58</sup>"Jammers Add Effectiveness, Complexity," *Aviation Week and Space Technology*, 27 January 1975, pp. 63-77.

<sup>59</sup>"One measure of Soviet understanding of the importance and principles of electronic warfare is to be found in the contents of a 444-page textbook published in the USSR in 1968, entitled 'Principles of Jamming and Electronic Reconnaissance,' authored by S. A. Vakin and L. N. Shustov. One long-time U.S. airborne countermeasures designer describes the book's contents as 'very impressive.' The Soviet textbook on electronic warfare (which was translated by the USAF's Foreign Technology Division in 1969), reveals that Russian specialists are well aware of the vulnerability of conical-scan type radar to (this kind of) deception." "Jammers add Effectiveness, Complexity," *Aviation Week and Space Technology*, 27 January 1975, pp. 63-77.

elevation target position errors. Another type of deception is range gate stealing, in which the repeater retransmits the skin echo at high power and then progressively introduces time delays, stealing away the "range gates" and causing the threat emitter to track the stronger false target. These techniques and others must be assumed to be capabilities of Soviet fighters, particularly in those cases where ECM pods are carried.

Both the MIG and SUKHOI OKB's made improvements to existing designs and created new ones in this time period. New avionics systems, better powerplants, increased attention to ECM and greater ordnance-carrying capacity characterize the aircraft designed from 1964-1973.

#### D. 1973-1985, THE RISE OF AIR COMBAT

The MIG and SUKHOI OKB's developed and sent to production facilities many new fighter designs in this most recent time period. Several improved upon old designs, in some cases with marginal upgrades; others contained such great improvements that new designators were assigned. Among the former, MIG created the FLOGGER G in about 1975, incorporating a better AI radar than that on the FLOGGER B. The FLOGGER G also was given a new powerplant, the Tumanskiy R-29 replacing the R-27. The change boosted the FLOGGER G's military power and maximum (afterburning) thrust, increasing both sea level Mach performance (Mach at altitude was not affected) and thrust-to-weight ratio. The Soviets have been continually searching for better propulsion systems for their fighters. That they are keenly interested in Western developments is undeniable (see Figure 26, next page).

MIG also brought out a new version of the FLOGGER ground attack variant, the FLOGGER J. Open sources indicate only that the FLOGGER J includes new nose sensors to improve ground attack performance. SUKHOI also improved its ground attack offerings with the FITTER H and FITTER K. Among the improvements in these aircraft is the modification of the dorsal spine, possibly permitting increased internal fuel tankage or additional avionics and ECM. A large number of these aircraft are used in the tactical reconnaissance role.

The basic FOXBAT airframe was retrofitted with a new AI radar, giving the newly-created FOXBAT E a limited lookdown/shootdown capability similar to that found on the FLOGGER air-to-air fighters. The FOXBAT E also now carries new AAMs (AA-7 APEX and AA-8 APHID) instead of or in addition to its older AA-6 ACRID AAM's.

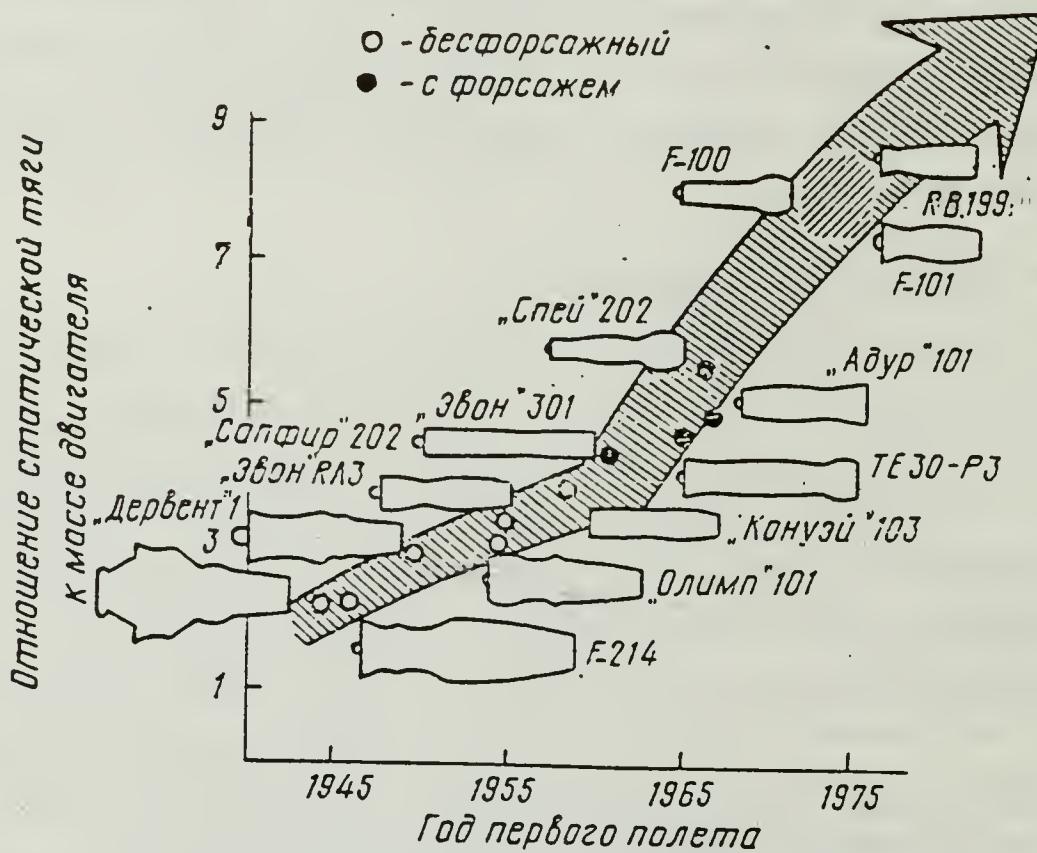


Рис. 44. Рост отношения тяги к массе для военных реактивных двигателей

Y axis: Engine thrust-to-weight ratio

X axis: Year of first flight

Source: Ponamarev, *Aviatsiya*, p. 188.

The Tumanskiy R-29 "is simpler than the corresponding American F-100 (upper right of above graph), with fewer compressor stages and a much lower pressure ratio; but it is more powerful." *Janes All the World's Aircraft*, 1984-1985, p. 845.

Figure 26. Soviet Interest in Western Propulsion Systems

The FOXHOUND, designed about 1974, uses the basic FOXBAT airframe, but has a longer fuselage and extended empennage. Air inlets are also slightly changed. FOXHOUND also has a two-seat cockpit, a new pulse-Doppler AI radar and eight new AAM's, including the long-range, radar-guided AA-9.<sup>60</sup> The Department of Defense has stated that

the documentation on the F-18 fire control radar served as the technical basis for new lookdown/shootdown engagement radars for the latest generation of Soviet fighters.<sup>61</sup>

Until very recently, Soviet fighters have not had the ability to engage targets flying near the ground, because their AI radars have "lost" the relatively weak target radar echo in the "clutter" caused by the ground or sea (which reflects radar energy). The development of computers and software to distinguish the target from the ground clutter meant that the Soviets were no longer limited to "blue-sky shots."

Other important features on the new generation of AI radars also add to combat capability. In the past, different parts of the target aircraft being illuminated presented echo returns of various strength, which caused the tracking radar to shift its aim point around the target, "introducing spurious angular rate data into the lead angle computation."<sup>62</sup> New techniques eliminate this "glint" problem.

Another valuable feature is "raid assessment," which allows pilots to determine the size of incoming raids beyond visual range (BVR). Track-while-scan is a feature that allows a pilot to look for and engage multiple targets simultaneously. Previously, AI radars had two modes: search and track. One could not be in operation while the other was engaged. Track-while-scan (TWS) allows the pilot to track one or more targets while continuing to search for more enemy aircraft.

---

<sup>60</sup>"The extended range and track-while-scan radar capability for the aircraft was developed and tested extensively in the MIG-31 [FOXHOUND] against a variety of targets including drones simulating cruise missiles at Vladimirovka, a test site on the Caspian Sea . . . The FOXHOUND is designed to cruise at high altitudes and engage fighter targets in the look-down/shoot-down mode with radar-guided missiles. In tests with the FOXHOUND's weapon system, Soviet pilots successfully intercepted targets with a radar signature under 1 square meter at altitudes below 200 feet while (themselves) flying at an altitude above 20,000 ft." Clarence A. Robinson, Jr., "Soviets Deploying New Fighters," *Aviation Week and Space Technology*, 28 November 1983, pp. 18-20.

<sup>61</sup>*Military Significant Western Technology*, p. 8.

<sup>62</sup>Phillip J. Klass, "New Radar Developed for F-18," *Aviation Week and Space Technology*, 16 January 1978, p. 55.

TWS is a feature designed to work with active radar-guided missiles, which can be launched in a "fire and forget" mode.<sup>63</sup> The FOXHOUND's AI radar has been reported to be "able to handle 20 targets, tracking four and identifying the rest even in ground clutter."<sup>64</sup> This would give it a capability remarkably similar to the US F-14 TOMCAT, whose AWG-9 AI radar can "(detect and track) more than 20 targets while launching and guiding six different targets."<sup>65</sup> And in fact, "some intelligence officials believe that technology has been obtained by the Soviets from F-14's in Iran."<sup>66</sup> The US Department of Defense has publicly confirmed that F-14 fire-control radar documentation has been compromised.<sup>67</sup>

In this time period the SUKHOI OKB designed the SU-25 FROGFOOT for close-air support of ground forces. Its mission makes the FROGFOOT the Soviet counterpart to the USAF A-10, although in planform it resembles the Northrop A-9, which lost the USAF competition to Fairchild's A-10 design. The SU-25 has very high aspect-ratio wings (6.42), non-afterburning engines, and ten weapons pylons--it is clearly designed for the close air support role. The FROGFOOT has been in service in Afghanistan since 1981, where it has been engaged primarily in coordinated low level close air support operations with MI-24 helicopter gunships.

The MIG-29 FULCRUM is comparable in size to the USAF F-16 FALCON but has an advanced AI radar, new AAM's, new engines, greater combat radius, and better turning performance than its predecessors. It includes the "state-of-the-art avionics evolving from systems designed originally for the FOXHOUND."<sup>68</sup> Unlike the FOXHOUND, however, the FULCRUM has a thrust-to-weight ratio greater than unity, lower wingloading, and can attain Mach 1.2 at sea level. The SU-27 FLANKER has slightly better capabilities.

---

<sup>63</sup>Previously, "radar-guided" AAM's actually were "semiactive radar-guided" because they required the platform aircraft to "paint the target 'til the missile splashed"--the weapon simply received reflected radar energy. The disadvantage of such a system is that it requires the launch aircraft to remain pointed at its target, a vulnerability in air-to-air combat.

<sup>64</sup>David M. North, "Soviets Test Two-Seat MIG-25 Version," *Aviation Week and Space Technology*, 28 March 1977, p. 18.

<sup>65</sup>Clarence A. Robinson, Jr., "US Reexamines Fighter Needs," *Aviation Week and Space Technology*, 23 April 1979, p. 19.

<sup>66</sup>"Soviets Press Production, New Fighter Development," *Aviation Week and Space Technology*, 16 March 1981, p. 56.

<sup>67</sup>*Militarily Significant Western Technology*, p. 8.

<sup>68</sup>Robinson, "US Reexamines Fighter Needs," p. 19.

Two trends are discernible in this period. One is the progressively improved ability to detect and engage BVR targets. The second is the increased maneuverability of Soviet fighters. The ability to detect targets at a distance is a function of the AI radar's search capability. The greater the radar's power, the earlier the detection. If a target can be acquired without giving away one's presence, then the attacker has the advantage in the form of surprise. The importance of surprise cannot be overstated because "four out of every five aircraft shot down by fighters never saw their assailant."<sup>69</sup> The second trend, greater maneuverability, is also important because, if surprise is the most important attribute of successful air combat, the ability to outmaneuver the adversary comes in second; it confers the ability to stay out of the enemy's weapons lauch envelope and to continually threaten him.

The evolution of AI radar search and track capability is shown in Figures 27 and 28 (next page). Also important to the development of a first-look, first-shot capability are long-range missiles. Figure 29 (page 57) shows the evolution of maximum AAM ranges. This increasing capability is reflected in the frequent Soviet assertion that historically, 70 percent of all air-to-air kills were made on the first pass.<sup>70</sup> As designers have over the years created more maneuverable fighters with greater combat persistence, the Soviets have increasingly noted that the first pass probability is not always 100% and have apparently experimented on a limited basis to develop tactics that reposition the fighter for another shot opportunity. This interest in maneuvering air combat increases when the Soviets have received fighters capable of maneuvering (i.e., with relatively high thrust-to-weight ratios and reduced wingloadings; see Figures 30 and 31, pages 57 and 58).

These two trends now exist simultaneously. On the one hand, technology has again made it possible to engage in certain types of close-in, hard-turning air combat, while at the same time, new weapons and electronics have given fighter aircraft long-range, off-boresight kill capabilities that relax the past requirement for stern conversion. Figure 32 (page 59) captures the unambiguous trend in first-look, first-shot capability, Figure 33 (page 60) shows the evolution of "maneuverability;"

---

<sup>69</sup> Gunston, *Modern Air Combat*, p. 187.

<sup>70</sup> "Since the first pass would be made under GCI control, and the attack would be at very high airspeeds and at relatively long ranges with radar missiles, a second pass at the target did not seem likely. There would be no need for close combat to occur." Rana Pennington, "Pilot Initiative in the Soviet Air Force," in Murphy, *Soviet Air Forces*, pp. 149-156.

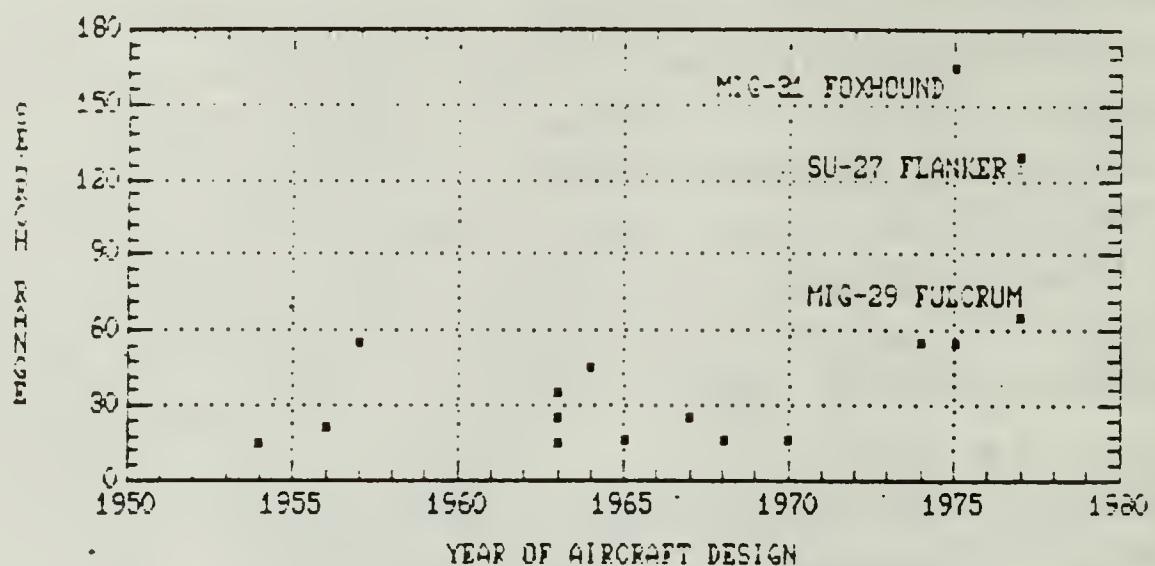


Figure 27. Evolution of AI Radar Search Range

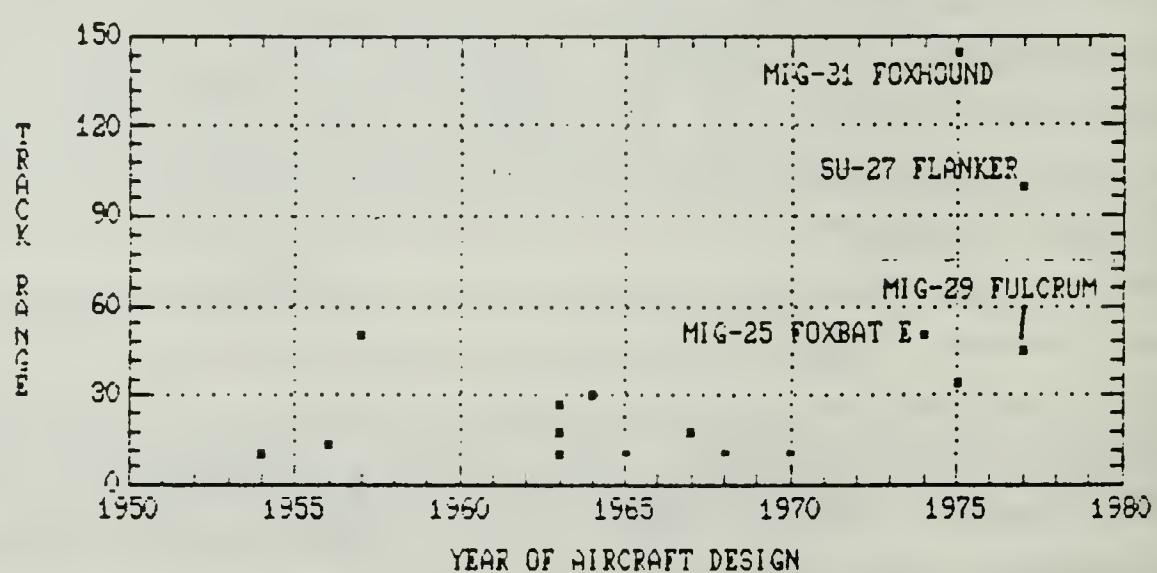


Figure 28. Evolution of AI Radar Track Range

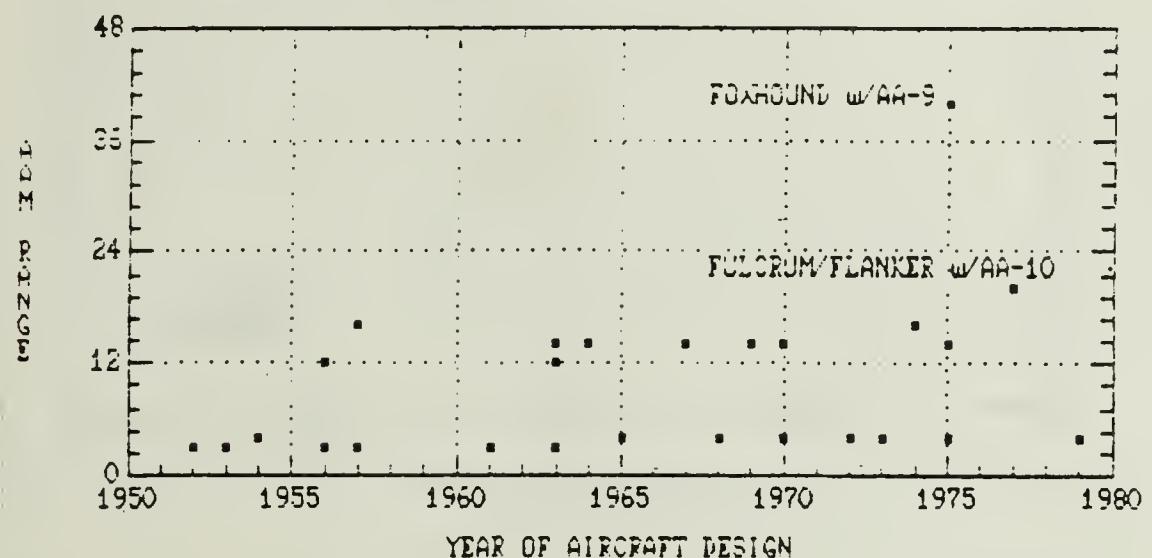


Figure 29. Evolution of AAM Range

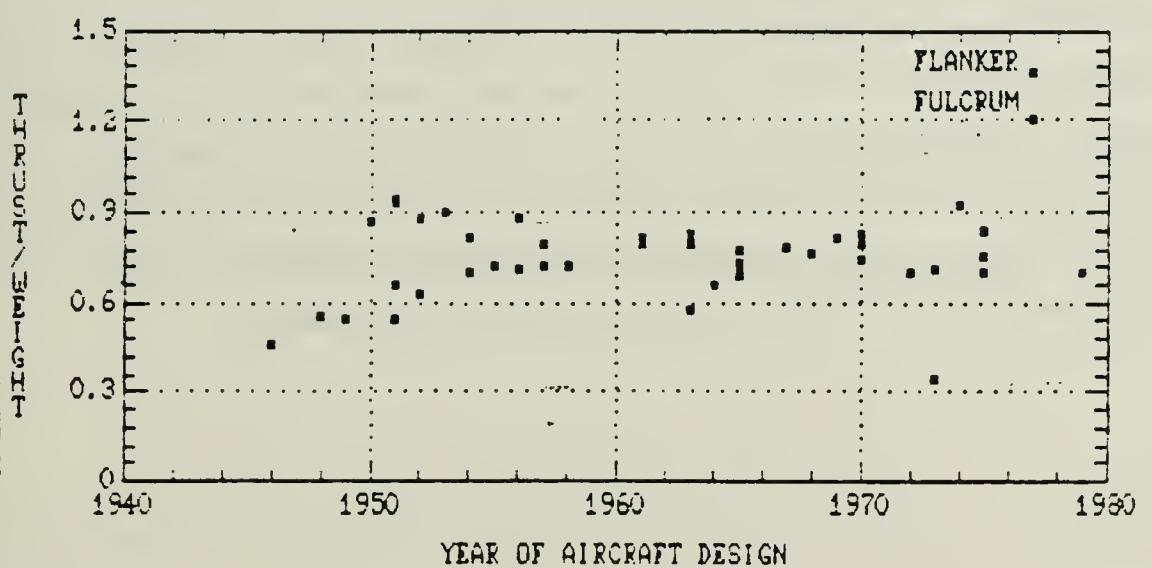


Figure 30. Evolution of Thrust-to-Weight Ratio (lbs) (1945-1980)

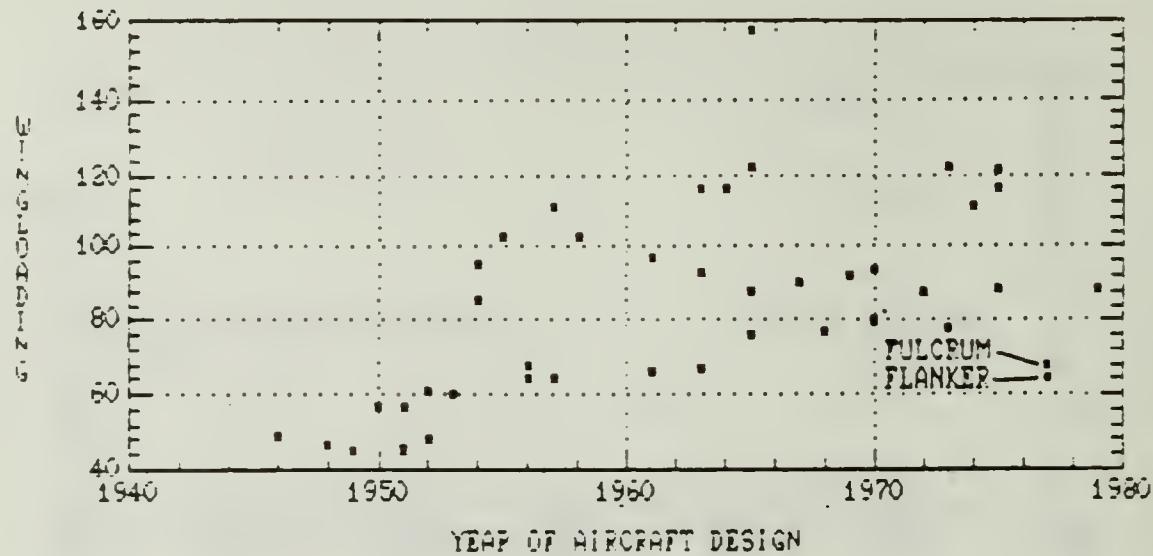


Figure 31. Evolution of Wingloading (1945-1980)

greatest ability to maneuver is in the far corner (upper left rear). If we use SEARCH to stand for long-range kill capability (it is correlated to TRACK at higher than .99 and MSLRANGE at higher than .95), we can combine these two trends.<sup>71</sup> Maximum maneuverability and maximum kill-range are shown in Figure 34 (page 60) in the far corner.

Since 1973, then, the Soviets have developed a new aircraft especially for the close air support (CAS) role, new aircraft approaching a first-look, first-shot capability, and increasingly maneuverable fighters with advanced avionics and weapons. Before looking at the interaction between these technological developments and Soviet tactical air employment doctrine, it is necessary to turn to the evolution of Soviet military doctrine since World War II. This topic is covered in the next section.

<sup>71</sup>SEARCH, TRACK and MSLRANGE are the names of three variables in this thesis' data base. For a more complete description of the data base, including the aircraft included in the study, see Appendix A.

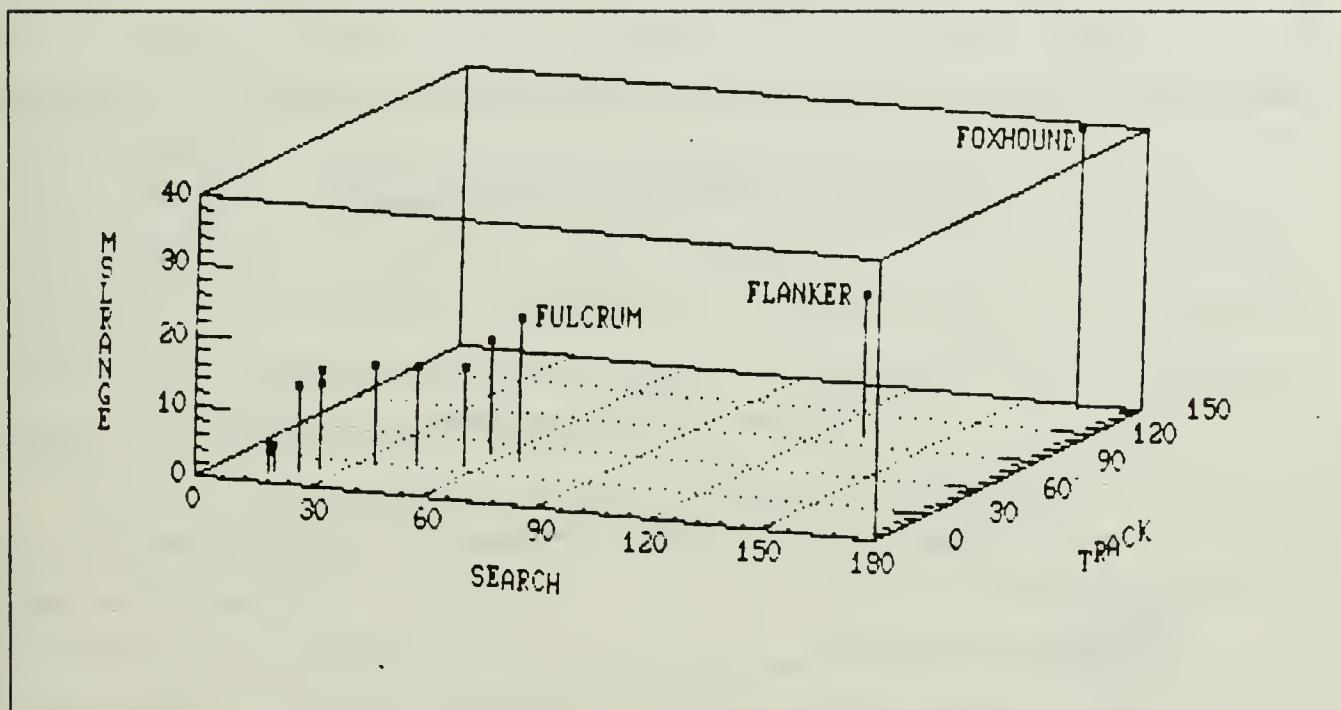


Figure 32. Evolution of Long-Range Kill Capability

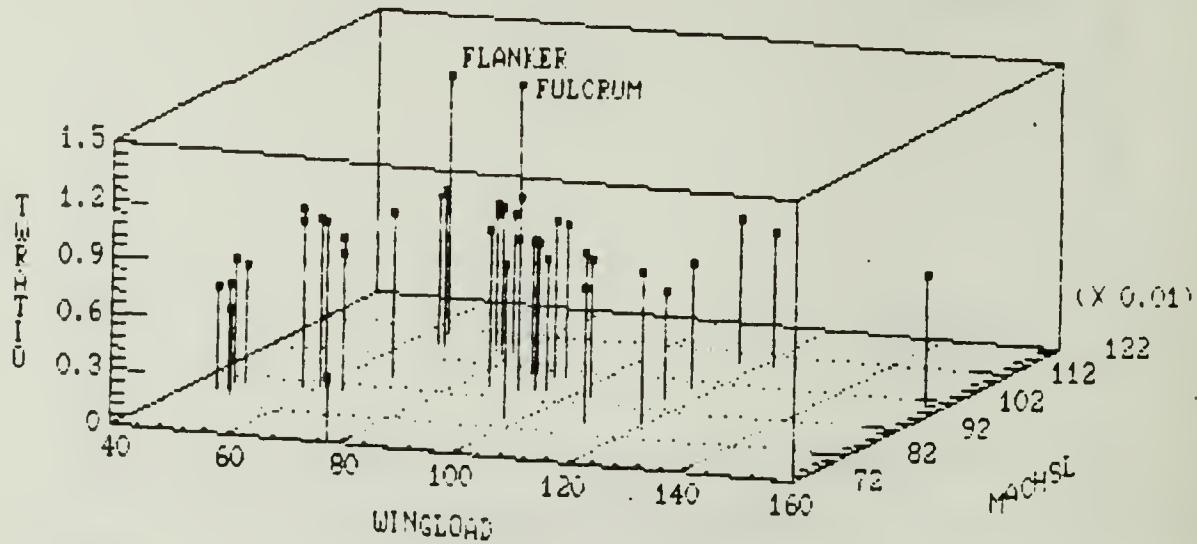


Figure 33. Evolution of Maneuverability

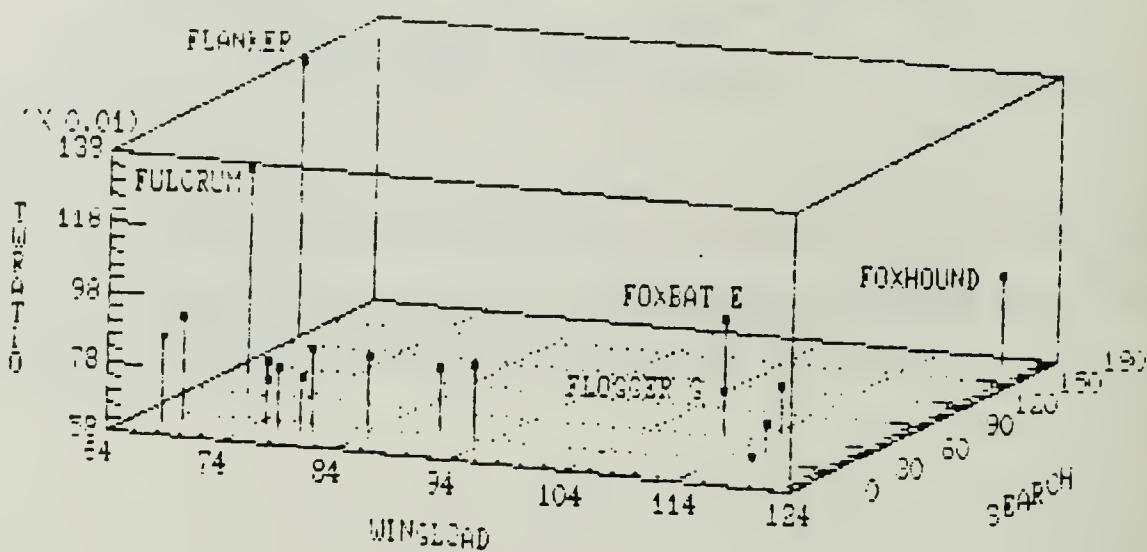


Figure 34. Evolution of Maximum Maneuverability and Maximum Kill-Range

## IV. THE EVOLUTION OF AIR EMPLOYMENT DOCTRINE

### A. 1945-1953, THE STAGNATION OF MILITARY DOCTRINE

The immediate postwar period (1945-1953) was one of little doctrinal innovation and characterized by strict adherence to Stalin's "five permanent operating principles." These five principles (the stability of the rear, the morale of the army, the quantity and quality of the divisions, armament, and the organizing ability of the commanders) were formulated in 1941 as the basis for Soviet military thinking. They are some of the most important principles for the conduct of conventional warfare and the conventional war concept dominated Soviet military thinking until long after Stalin's death in 1953. As a result, Soviet military thinking in the early- to mid-fifties was little different than Soviet military thinking had been in the Second World War. The Stalinist legacy was a straitjacket on the development of doctrine and inhibited the exploration of ideas regarding nuclear weapons and intercontinental war. Despite the fact that nuclear weapons were under development in the Soviet Union at this time, no doctrinal discussion was allowed during Stalin's lifetime.<sup>72</sup>

This same point is made in a number of studies of Soviet doctrine of the period. H.S. Dinerstein explains that Stalin's formulation of the five permanently operating principles "became the last and only word on the subject for more than ten years."<sup>73</sup> Dr. Jonathan R. Adelman also criticizes Stalin's omissions in formulating Soviet military doctrine. He refers to the importance of surprise, nuclear weapons, and the impact of foreign military doctrine. Like Dinerstein, Adelman points out that "Stalinist

---

<sup>72</sup>Harriet Fast and William F. Scott, *The Armed Forces of the USSR* (Boulder: Praeger, 1979), pp. 38-46.

<sup>73</sup>Dinerstein goes on to criticize the concept, saying: ". . . This formulation is so truistic as to be almost devoid of meaning. Obviously the country with the stronger economy, the better morale, superior equipment, larger forces, and abler commanders will win the war. The only really substantive point in Stalin's formula was his conclusion from the above premises: that transitory factors such as surprise could not determine the outcome of the war. He argued that the Germans, who had already lost the advantages derived from surprise, would lose the war because they were inferior in the permanently operating factors." H. S. Dinerstein, *War and the Soviet Union: Nuclear Weapons and the Revolution in Soviet Military and Political Thinking* (New York: Praeger, 1959), pp. 6-7.

military doctrine generally emphasized conventional land war over possible nuclear air war.<sup>74</sup>

Soviet analysts in the post-Stalin period shared this view. Writing in the Soviet General Staff journal, *Voennaya Mysl'* (Military Thought), in 1964, General Major S. Kozlov said:

In the first postwar period (1946-1953) the development of Soviet military theory predominantly proceeded along the traditional path of generalization and analysis of the experience of the past war, of working out on this basis conclusions<sup>75</sup> and recommendations for the conduct of armed conflicts by conventional means.

This analysis meant that the Soviets saw victory in a future war as resulting

from the accumulation of successful battles fought along continuous and slowly changing fronts. Frontal breakthroughs would be achieved by the deliberate massing of soldiers and equipment on the main axis of attack, with a high density of men, tanks, artillery, and planes in the strike sectors, followed by envelopment and thrusts to the rear.<sup>76</sup> Ground forces would be predominant in the European theater of a future war.

Still other observers of Soviet military doctrine repeat this refrain. Raymond Garthoff blames "the legacy of Stalinist stagnation" on the "virtual canonization" of Stalinist military doctrine as it existed in 1945.<sup>77</sup> Stephen M. Meyer characterized the planning constraints placed on the General Staff in the postwar period as arbitrary.<sup>78</sup> In this regard, Soviet failure to discuss the importance of nuclear weapons and their impact on modern warfare did not, however, prevent them from developing their own nuclear weapons. Dinerstein points out that the decision to develop the new technology only means that the Soviets, while seeing them as important, did not

---

<sup>74</sup>Clearly, Soviet writers were significantly influenced by World War II; ". . . a future major war was seen as cast in the mold of World War II--that is, as a protracted land war in which ground troops, supported by tanks, artillery, and planes, would play the decisive role." Dr. Jonathan R. Adelman, "The Evolution of Soviet Military Doctrine, 1945-1984," *Air University Review*, March-April 1985, pp. 27-28.

<sup>75</sup>General Major S. Kozlov, "The Development of Soviet Military Science After World War II," *Voennaya Mysl'*, February 1964, p. 29.

<sup>76</sup>Adelman, "Evolution," p. 28.

<sup>77</sup>Raymond L. Garthoff, *Soviet Strategy in the Nuclear Age* (New York: Praeger, 1958), pp. 61-63.

<sup>78</sup>Stephen M. Meyer, *Soviet Theater Forces: Development of Doctrine and Objectives* (Letchworth: Garden City Press, 1983), p. 12.

consider them decisive.

Stagnant doctrinal development did not mean stagnant weapons development. It meant, rather, an absence of criteria for making the<sup>79</sup> best decision as to the allocation of resources among various weapon systems.

Thomas W. Wolfe argues that both Western and Soviet writers have judged Stalin too harshly. Although it is clear that most, if not all, hold Stalin responsible for the delay in Soviet doctrinal accommodation to the nuclear age, Wolfe explains that Stalin's orientation was "partly the product of necessity" and partly the result of his preoccupation with Europe. Because Stalin felt that the principal opponent in the postwar period would be the United States, which first had a monopoly on nuclear weapons and later an advantage in strategic nuclear delivery vehicles, the kind of conventional military power the Soviet Union could bring to a conflict would not be very effectively brought to bear directly against the United States.<sup>80</sup>

Even though the actual numbers of the Group of Soviet forces in Germany (GSFG) remained at a fairly constant 400,000 troops in the early 1950's, the Soviets upgraded and improved both the field armies and their supporting tactical air assets.<sup>81</sup> The development of Soviet tactical air assets was a consequence of Soviet experience in World War II. In that war, "the great majority of all Soviet Air Force activity . . . was directed towards the support of the ground forces."<sup>82</sup> Marshal Sokolovskiy has said that 76% of all Soviet Air Force (SAF) sorties flown in WW II were carried out by tactical air assets in support of the ground forces and that in the future, "the Air Force was destined primarily to support the ground forces in actions taking place directly

---

<sup>79</sup> Dinerstein, *War*, p. 9.

<sup>80</sup> "If the United States was to be deterred from pressing its nuclear advantage, the Soviet forces at hand would have to do the job, and the place where they could best be brought to bear was obviously Europe . . . the Soviet Union could in effect hope to make Western Europe a hostage for American good behavior . . . Lacking as yet the means to adopt a strategy of nuclear deterrence . . . Stalin had no choice . . . but to rely on Russia's traditional threatener forces as the primary instrument of Soviet military policy." Thomas W. Wolfe, *Soviet Power and Europe, 1945-1970* (Baltimore: Johns Hopkins Press, 1970), pp. 33-37.

<sup>81</sup> Within the Ground Forces, the Soviets increased battlefield mobility and firepower with new tanks (T-54) and artillery, as well as mechanizing the logistics train. The 24th Air Army in East Germany included some 500 MIG-15 FAGOT fighters by 1952 and began to receive the MIG-17 FRESCO fighters in 1953. Wolfe, *Soviet Power*, pp. 39-40. Also, Robert A. Kilmarx, *A History of Soviet Air Power* (New York: Praeger, 1962), p. 229.

<sup>82</sup> M. J. Armitage and R. A. Mason, *Air Power in the Nuclear Age* (Urbana: University of Illinois Press, 1983), p. 141.

over the battlefield."<sup>83</sup> Another observer of Soviet air activity in WW II says that the SAF was

thoroughly imbued with the spirit of the offensive throughout the depth of the whole offensive zone, concentrating on the lines of the main land force thrusts.<sup>84</sup>

Thus, the legacy of WW II to the SAF and its employment concepts was one which ostensibly concentrated the main strength of the SAF on the battlefields and close enemy rear areas.

As was pointed out earlier, however, ground attack was not the orientation of Soviet fighter design at this time. The immediate postwar years were a time of significant changes to the wing, designed to make the aircraft fly higher and faster in the air defense role. The impetus for air defense designs came from outside the Soviet Union; German aircraft, prototypes, test data, factories, designers, engineers, and production personnel were all captured by the Soviets at the end of the war. This was truly acquisition of foreign technology on a massive scale. However, it was technology oriented towards Germany's defense problems, not the USSR's. Thus, although Germany was designing air defense aircraft to cope with US and British strategic bombing, and even though the Soviets' avowed air employment concept was of the ground attack variety, the USSR nevertheless incorporated German technology into its new aircraft designs.

This had important consequences for the way fighters were used in the Korean War. One would have expected, looking at their doctrine, that Soviet-trained Communist forces would fly ground attack missions in the Korean War. In fact, however, Chinese air employment concepts suggest a predilection for the air defense mission. The Soviet-supplied, Soviet-trained, and in some cases Soviet-flown, Chinese Air Force MIG-15 and MIG-17 fighters were not flown in support of ground force actions, even in the north. They were used for air defense against UN bombers involved in interdiction missions over northwest Korea.

---

<sup>83</sup> Marshal of the Soviet Union V. D. Sokolovskiy, *Military Strategy, Soviet Doctrine and Concepts* (London: Pall Mall, 1963), pp. 130, 158.

<sup>84</sup> Armitage and Mason, *Air Power*, p. 141, citing I. V. Timokhovich, *The Operational Art of the Soviet Air Force in the Great Patriotic War* (Moscow: Voenizdat, 1976), p. 9.

This, of course, is how the Soviets trained them to fly their fighter aircraft. The Soviets in turn employed their tactical fighter assets in the manner they did, not because their military doctrine so directed them (it directed that ground attack missions should be flown), but rather, because the available technology drove them to pursue air defense-type missions. At the same time, the recently-acquired German air defense technology constrained them from executing the types of ground attack missions one would have expected by looking at their military doctrine.

## B. 1954-1964, A PERIOD OF TRANSITION

When Stalin died in 1953, an era of Soviet military doctrine is widely held to have come to an end. However, the near unanimity that attends characterizations of the 1945-1953 period disappears in descriptions of the post-Stalin era. For example, the Scotts claim the impact of Stalin's death was immediate.<sup>85</sup> Like the Scotts, Dr. Adelman also claims that, "freed from the straitjacket of postwar Stalinism," the Soviet military went through "rapid and radical changes" in doctrine, and that the

dominant motif of the period (1954-1964) was a recognition of the revolution in military affairs wrought by the advent of nuclear weapons and missile technology.<sup>86</sup>

Thomas Wolfe, however, claims that the Stalinist tradition persisted after his passing.<sup>87</sup> Stephen Meyer also argues that the Soviet military leadership maintained some important ideas left over from the Stalinist period.<sup>88</sup>

It is clear that there is little agreement on the nature of the doctrinal changes in the years after Stalin's death. Although all the authors identify the period as one in which the Stalinist hold on military thinking is relaxed, there is no such agreement as

---

<sup>85</sup> Scott and Scott, *Armed Forces*, p. 39.

<sup>86</sup> Adelman, "Evolution," p. 29.

<sup>87</sup> "Stalin's persistent endeavor to improve Soviet capabilities for theater warfare in Europe was to help prolong the dominance of a continental military tradition in the Soviet strategic outlook." Wolfe, *Soviet Power*, p. 35.

<sup>88</sup> "The first was that strategic bombing of an enemy's population centers and economic-industrial facilities was likely to be ineffective in forcing capitulation . . . . The second impression was that, while nuclear weapons did represent an enormous increase in deliverable firepower, they were not decisive (or absolute) weapons . . . . Nuclear weapons were not the principal means of military combat, but would continue to play a supportive role in military operations . . . . The balanced development of all combat arms was necessary, with the Ground Forces as the main arm." Meyer, *Theater Forces*, pp. 12-13.

to how quickly the Soviets adapted their ideas to new technology and other military doctrines, notably that of the United States. In fact, the period should be considered transitional; it was characterized by a number of extensive doctrinal debates within the professional Soviet military journals and newspapers, and there were many cases of public reversals of opinion and even public reprimands. All of these suggest that a great deal of uncertainty surrounded the development of new weapons and the consideration of new doctrines and employment concepts. The decade from 1954-1964 emerges as one of doctrinal uncertainty, confusion, and ambivalence.

In July 1953, five months after Stalin's death, Admiral of the Fleet N. Kuznetsov was quoted by *Pravda* as saying, "The experience of the Great Fatherland War alone is no longer sufficient."<sup>89</sup> Raymond Garthoff says that this offhand comment in fact betrays the inadequate theoretical foundation of military doctrine.<sup>90</sup> In September, *Voennaya Mysl'* carried an article by General Major N. A. Talenskiy that appeared to criticize the long-standing Soviet reliance on Stalin's five permanent operating principles.<sup>91</sup> The Scott's say that Talenskiy did not actually challenge Stalin's formulation, but did imply that the five permanent operating principles were not basic.<sup>92</sup> Dinerstein, on the other hand, says that "Talenskiy rejected Stalin's formula" and that "for the first time since 1945 a Soviet publication had envisaged a possible war of the future essentially different from World Wars I and II."<sup>93</sup>

Talenskiy's article opened the floodgates of discussion as nearly a dozen articles and letters on theoretical issues were published in the following year. Garthoff argues persuasively that "no official line on the subject existed" and that "this was a real, and not a staged, discussion."<sup>94</sup> As well, it seems fairly safe to suggest that Talenskiy's ideas were responsible ones, as he had for several years been the editor of the military newspaper, *Krasnaya Zvezda* (Red Star), and at the time of his article in *Voennaya Mysl'* (September 1953) he was chief editor of that professional journal. Nevertheless,

---

<sup>89</sup>Admiral of the Fleet N. Kuznetsov, *Pravda*, 26 July 1953. Quoted in Garthoff, *Soviet Strategy*, p. 63.

<sup>90</sup>Garthoff, *Soviet Strategy*, p. 63.

<sup>91</sup>General Major N. Talenskiy, "On the Question of the Character of the Laws of Military Science," *Voennaya Mysl'*, November 1953, p. 30.

<sup>92</sup>Scott and Scott, *Armed Forces*, p. 40.

<sup>93</sup>Dinerstein, *War*, p. 9.

<sup>94</sup>Garthoff, *Soviet Strategy*, p. 10.

despite the absence of an "official" line in 1953, the Scotts claim Talenskiy had clearly committed an indiscretion, as he was removed from his position as editor of the journal in June 1954 and "banished" to the Institute of History in the Soviet Academy of Sciences.<sup>95</sup> Furthermore, the issues he had raised in his article were dealt with in summary fashion by Defense Minister A. M. Vasilevskiy in a February 1954 article he wrote for the Soviet military newspaper, in which he reiterated the Stalinist position.<sup>96</sup> Later that same year the Minister of Defense repeated his position that "the outcome of a war is determined . . . by permanently operating factors."<sup>97</sup>

The following year Marshal Zhukov became the new Minister of Defense. The Scotts state that when Zhukov assumed his new command, he criticized Stalin's permanent operating principles in a secret speech to his top officers.<sup>98</sup> In February 1955 Tank Marshal P. Rotmistrov published an article in *Voennaya Mysl'* which publicly, sharply, and permanently broke with the Stalinist legacy.<sup>99</sup> Rotmistrov argued that surprise (characterized by Stalin as a transitory factor) had throughout history been of great significance in combat. Now, in an age of nuclear weapons, surprise could determine the outcome of the entire war. Thus, Mark Miller says that "taken together, the Rotmistrov and Talenskiy articles, in effect, repudiated the permanently operating factors as the basic law of war."<sup>100</sup> By the end of 1955, Stalin's hold on Soviet military thought seems to have been loosened considerably--within "the year, Stalin's military views appear to have been rejected by the majority of Soviet military theoreticians."<sup>101</sup>

Nevertheless, although the five permanent operating principles were no longer considered sufficient as basic laws of war, they did continue to exercise their influence in that (being truisms, as Dinerstein pointed out) they were reflected in "two threads of

---

<sup>95</sup> Scott and Scott, *Armed Forces*, p. 40.

<sup>96</sup> Marshal of the Soviet Union A. Vasilevskiy, "On Guard Over the Security of Our Soviet Motherland," *Krasnaya Zvezda*, 23 February 1954. Scott and Scott, *Armed Forces*, p. 40.

<sup>97</sup> Marshal of the Soviet Union A. Vasilevskiy, "The Great Lesson of History," *Krasnaya Zvezda*, 7 May 1954. Scott and Scott, *Armed Forces*, p. 40.

<sup>98</sup> Scott and Scott, *Armed Forces*, p. 40.

<sup>99</sup> Marshal of Tank Forces P. Rotmistrov, "On the Role of Surprise in Contemporary War," *Voennaya Mysl'*, February 1955, pp. 18-19.

<sup>100</sup> Mark E. Miller, *Soviet Strategic Power and Doctrine: The Quest for Superiority* (Coral Gables: Current Affairs Press, 1982), p. 34.

<sup>101</sup> Scott and Scott, *Armed Forces*, p. 70.

continuity" running through Soviet military doctrine into the late 1950's. Stephen Meyer identifies these as being that "war could only be won by destroying the enemy's military forces; and nuclear weapons were not the decisive means of warfare."<sup>102</sup>

General Major G. I. Pokrovskiy makes a similar point in his book:

But strategic weapons, by their very nature, cannot be considered as independent and self-sufficient. The only correct view regarding the use of various weapons in warfare is the view of Soviet military science: to wit, that all forms of armaments and technology must be employed in warfare in as close and well-organized combined operation. Under such conditions, strategic weapons must be regarded as a part of the armament of the armed forces, entering into the general system as an important and irreplaceable link, but not replacing and supplanting any other means of combat. Soviet military science teaches that, without well-organized combined operations of all arms and services (land armies, air forces, and naval fleets), one cannot successfully wage contemporary warfare.<sup>103</sup>

General of the Army K. Moskalenko makes a similar argument in an article he wrote for *Krasnaya Zvezda*, as does Marshal Rotmistrov.<sup>104</sup> Garthoff noted this in his survey of doctrinal writings.<sup>105</sup> He further argues that even the organizational structure of the Soviet Ministry of Defense reflected the Soviet commitment to a combined arms doctrine of warfare, with emphasis on the importance of the Army.<sup>106</sup>

In August 1957 the Soviets successfully launched an intercontinental ballistic missile (ICBM) and in October of that year the world's first artificial satellite, Sputnik I. The impact of missile technology on Soviet military doctrine was significant, if not

---

<sup>102</sup> Meyer, *Theater Forces*, p. 13.

<sup>103</sup> General Major G. I. Pokrovskiy, *The Role of Science and Technology in Modern War* (Moscow: Voenizdat, 1956). Translated by Raymond Garthoff (New York: Praeger, 1958), p. 70.

<sup>104</sup> "Soviet military science decisively rejects [that one can] achieve strategic victory by means . . . of one or another new weapon . . . no such weapons . . . possess . . . all-powerful qualitites. Historical experience teaches that with the appearance of new technology, new more powerful and more destructive weapons, the significance of men on the battlefield not only does not decrease, but increases all the more." General of the Army K. Moskalenko, *Krasnaya Zvezda*, 25 September 1954. Also, "It is entirely clear that atomic and hydrogen weapons alone, without the decisive operations of the ground forces with their contemporary material cannot decide the outcome of the war." Rotmistrov, "Role of Surprise," p. 25.

<sup>105</sup> Garthoff's survey of "all available Soviet military periodical and other publications reveals at least eighty specific reaffirmations of the rejection of reliance on one-weapon strategies in the period 1953 through 1957, and none diverging from it." Garthoff, *Soviet Strategy*, p. 76.

<sup>106</sup> "The Army is predominantly represented (the senior dozen military chiefs all are Army, including the head of the combined Air Defense Forces, with the Navy and Air Force chiefs currently ranking about thirteenth and fourteenth in standing), and the General Staff of the Armed Forces is the former Army General Staff upgraded." Garthoff, *Soviet Strategy*, p. 82.

immediate. The Soviets saw in the ICBM an opportunity to break the US advantage in strategic nuclear delivery vehicles, which in the late 1950's were the bombers of Strategic Air Command.<sup>107</sup> Garthoff claims that this view was disseminated in part for propaganda purposes and that, in fact, the true evaluation by the Soviet military of the bomber threat was less extreme.<sup>108</sup> In addition, Stephen Meyer says that

The pairing of powerful thermonuclear warheads with long-range missiles (i.e., IRBM and ICBM) was an obvious combination. By 1958 some prominent Soviet military leaders began<sup>109</sup> to point to the nuclear rocket weapon as the decisive weapon of the times.

And indeed they were, as Dinerstein makes clear in quoting General Major Talenskiy's March 1958 characterization of the intercontinental ballistic missile as a "decisive weapon."<sup>110</sup> This period saw what the Scott's say are "radical changes in all aspects of warfare," following the introduction of the nuclear weapon and the missile.<sup>111</sup>

Just prior to these developments in missile technology, the XXth Party Congress was held in 1956, at which Khrushchev denounced Stalin and called for a reexamination of military matters. In response to Khrushchev's proposal the Soviet General Staff began a series of seminars and discussions, in which all high-ranking officers participated. The result of these discussions was the determination that future

---

<sup>107</sup> Marshal Vershinin was quoted in a *Pravda* article in September 1957 as saying, "Now the expectation that America's remoteness will spare her military blows in the event of a new war is no longer tenable . . . great distances will no longer play a decisive role. What was once inaccessible has now become within easy reach. Intercontinental ballistic missiles can deliver the most terrible weapon, the hydrogen bomb, instantly to the remotest regions on any continent on earth . . . missiles now call into question the expediency of further developing bomber aircraft, since the former are more reliable and dependable." Marshal of Aviation K. A. Vershinin, "On the Bellicose Statements of American, British and West German Generals, Answers of the Commander-in-Chief of the Air Forces of the USSR, Marshal of Aviation K. A. Vershinin, to Questions by the *Pravda* Correspondent," *Pravda*, 8 September 1957.

<sup>108</sup> Garthoff, *Soviet Strategy*, p. 223.

<sup>109</sup> Meyer, *Theater Forces*, p. 14.

<sup>110</sup> "General Major Talenskiy said in so many words that intercontinental ballistic missiles were decisive weapons. By this time there could be no doubt that Talenskiy spoke for others beside himself . . . the Soviet monopoly possession of the decisive weapon of our time . . . the Soviet Union employs the major advantages it has gained from possession of the decisive modern weapon." Garthoff, *Soviet Strategy*, p. 227n.

<sup>111</sup> Scott and Scott, *Armed Forces*, p. 41.

Soviet military doctrine should be based on the availability of nuclear weapons and missiles.<sup>112</sup>

Penkovskiy tells us that at the time, the proceedings and conclusions of the seminars were state secrets, but were gathered together in a "Special Collection of Articles," and published for the benefit of educating the Soviet officer corps. Penkovskiy's notes on the "Special Collection" were intended to provide the West with a clear picture of the new military doctrine under development in the Soviet Union. Among the features of this new military doctrine, according to Penkovskiy, were that: a future war would begin with a sudden nuclear strike, and; the war would be very short.<sup>113</sup>

In accordance with these changes in Soviet military doctrine, First Secretary Nikita S. Khrushchev played a large role in the creation in May 1960 of the Strategic Rocket Forces as a separate service of the Soviet armed forces. The Strategic Rocket Forces (SRF) represented the elite of the Soviet military. The Scotts observe that the SRF have, since their creation, always been considered the premier service and that the SRF commander has always taken precedence over the commanders of the other four services (Ground Forces, Air Force, National Air Defense, and Navy).<sup>114</sup> Khrushchev, in addition to presiding over these organizational changes in the Soviet military, also provided an outline of the new doctrine in his speech to the Supreme Soviet in January 1960. The speech assured the listeners that the USSR had large stockpiles of nuclear weapons and that

the Air Force and Navy have lost their former importance. These arms are being replaced and not reduced. Military aircraft is almost entirely being replaced by rockets. We have now drastically reduced, and will reduce further still, or even discontinue, the production of bombers and other obsolete aircraft.<sup>115</sup>

Khrushchev went on to say that

---

<sup>112</sup>Oleg Penkovskiy, *The Penkovskiy Papers* (New York: Doubleday, 1965), translated by Peter Deriabin, p. 248.

<sup>113</sup>Penkovskiy, *The Penkovskiy Papers*, p. 250.

<sup>114</sup>Scott and Scott, *Armed Forces*, p. 137.

<sup>115</sup>Nikita S. Khrushchev, speech to Fourth Session of the Supreme Soviet on 14 January 1960, *On Peaceful Coexistence* (Moscow: Foreign Languages Publishing House, 1961), pp. 148-163.

a country's defensive capacity is not determined by the number of men under arms . . . [but rather] depends in decisive measure on the firepower that country commands.<sup>116</sup>

As a consequence, Khrushchev defended manpower cuts in the armed forces from their 1955 level of 5.76 million down to 3.26 million in 1958. He also proposed to further cut manpower by over a million men.<sup>117</sup> This was a sharp break with the earlier view that nuclear weapons were not decisive and that "balanced development of all combat arms was necessary," with the Army remaining the dominant service.<sup>118</sup>

This revision of military doctrine elevated the new nuclear missile weapons to a privileged place in the Soviet defense schema. Navies, air forces, and ground forces all came to be seen as less important, if not already obsolete. Combined arms doctrine--in which all the services contributed to military operations by pursuing a single, integrated combat plan for the fulfillment of strategic objectives within the theater--no longer appears to have held sway. The dominant military assumption was that military goals could now be accomplished independently and exclusively by nuclear missiles.

Soviet military planners in this time frame were faced with having to try and find a niche for the air forces within the rather restrictive confines of this new military doctrine. Two elements combined to generate in the Khrushchev period a continued emphasis on air defense. First, with theoretical writings of the period increasingly emphasizing the importance of strategic nuclear weapons and the "threat" posed by the bombers of Strategic Air Command, it was to be expected that Soviet air employment concepts would gravitate toward the air defense mission. Second, technological advances had wrought havoc with Soviet military theory, rendering seemingly irrelevant the hard-won experience of World War II, including the importance of battlefield ground attack missions.<sup>119</sup> However, the Soviets' failure to fly ground attack missions in Korea, despite their declared intention to use aircraft in the future the way they had in World War II, can best be explained by pointing to the nature of fighter design in

---

<sup>116</sup> Khrushchev, *Coexistence*, pp. 148-163.

<sup>117</sup> Khrushchev, *Coexistence*, pp. 148-163.

<sup>118</sup> Meyer, *Theater Forces*, p. 13.

<sup>119</sup> Primarily as a result of Khrushchev's reforms, the Soviet military was wrenched out of its accustomed ways of thinking and forced to reorganize "in line with the technological facts of life, as he [Khrushchev] saw them." Wolfe, *Soviet Power*, p. 136. This meant shifting from an almost exclusive preoccupation with continental land warfare to a new concern for the difficulties imposed by strategic nuclear warfare.

the immediate postwar years; they had moved toward a capability of higher and faster flight with their newest fighters, making nearly impossible any serious contribution to ground support.

Beyond that, despite the fact that air defense had "always been the weakest part of Soviet air power . . . by 1955 the Soviet Air Force had all the major elements of a first-class strategic air defense organization."<sup>120</sup> As a result of these improvements, PVO Strany (National Air Defense) was made a separate independent service in 1955, which forced the Soviet Ground Forces to relinquish control over regional defense matters. This broke a forty-year tradition in which

all Soviet armed forces within a region were subordinate to the Army Commander. Now [1959] the PVO has its own independent headquarters, sometimes within the Arniy region, sometimes side by side with the Army organization.<sup>121</sup>

In addition, PVO appears to have had priority over the Air Force in selecting new pilots from flight school.<sup>122</sup>

The growing importance of air defense continued throughout the Khrushchev period until 1963, when the "bible" on Soviet military strategy appears. This was V. D. Sokolovskiy's *Soviet Military Strategy*.<sup>123</sup> Sokolovskiy's book offers some interesting contrasts to Khrushchev's 1960 "new strategy" speech. In particular, the Soviet military, unlike Khrushchev, was concerned about how to actually fight and win a future war, not just deter it through nuclear sabre-rattling, bluff, and bluster. Sokolovskiy thus insisted that the final victory in war could be assured only through the combined action of all arms and services. As part of this formulation then, he and those with whom he wrote saw "continued uses for tactical and fighter aviation, and a growing importance for the role of reconnaissance" aircraft in a future war.<sup>124</sup> This formulation was both a return to more traditional Soviet military views, as well as a "corrective" whose purpose was to realign Soviet air doctrine with its actual and

---

<sup>120</sup>Lee, *The Soviet Air Force*, pp. 109-120.

<sup>121</sup>Lee, *The Soviet Air and Rocket Forces*, p. 126.

<sup>122</sup>Lee, *The Soviet Air and Rocket Forces*, p. 126.

<sup>123</sup>V. D. Sokolovskiy, *Voennaya Strategiya*. Translated by the Rand Corporation as *Soviet Military Strategy* (Santa Monica: Rand Corporation, 1963).

<sup>124</sup>Sokolovskiy, *Military Strategy*, p. 54.

emerging capability. To this end, air doctrine was reoriented from strictly air defense to include other missions, such as reconnaissance and ground attack. Nevertheless, the impact of the recently-acquired air defense-oriented technology continued to influence Soviet doctrine.

Especially since the enunciation of "Flexible Response" by the Kennedy Administration, the Soviets perceived an increased emphasis placed on tactical air power by American and NATO planners. The Soviet response came in the form of air defense:

Because of the fact that tactical air forces in many armies are one of the main means for delivering nuclear weapons, air defense troops are becoming increasingly important to the ground forces . . . It is more important that the fighters of the air defense have the tactical and technical qualities, and the missile and electronic equipment, to enable them to reliably destroy enemy aerial targets at any altitude and at ranges that will protect the troops from enemy air attacks . . . the role and importance of the National PVO have increased immeasurably . . . Fighters will evidently play a considerable role in the National PVO system in the coming years. By increasing their speed, altitude, and range, and by improving their missiles and radar, fighters can continue to combat enemy bombers successfully. A modern air defense fighter must be able to remain aloft for a pro-longed<sup>125</sup> period, execute radar patrols, and shoot down enemy aircraft at any altitude.

But Sokolovskiy also defended the ground attack role and Soviet ability to execute it:

Tactical fighters and fighter-bombers will obviously still be able to support ground troops on the battlefield effectively . . . their speed and altitude must surpass those of enemy aircraft. Front line aircraft can be particularly effective in destroying enemy nuclear weapons, especially missiles, on the battlefield. Aircraft still have the important mission of aerial reconnaissance for all branches of the armed forces . . . Hence reconnaissance aircraft and instruments of aerial reconnaissance are continually being improved with respect to their ability to detect enemy targets traveling at high speeds and altitudes at any time of day and in any weather.<sup>126</sup>

Ultimately, Soviet force planners were able to generate political support for the reconnaissance and ground attack roles, both a motivating force for and a consequence of MIG's FOXBAT program and SUKHOI's new ground attack FITTER designs. By the end of the Khrushchev period then,

---

<sup>125</sup>Sokolovskiy, *Military Strategy*, pp. 344-345.

<sup>126</sup>Sokolovskiy, *Military Strategy*, p. 347.

the basic integrity of the ground forces and their supporting tactical air armies--which together comprised the combat backbone of the theater forces--was kept intact, and the validity of the combined arms doctrine under which they operated was emphatically reindorsed.<sup>127</sup>

The ten years from Stalin's death were a period of transition from the employment concepts of World War II to new concepts, which would ultimately find expression in the theater nuclear offensive. The early, post-Stalin years, however, were characterized by confusion, uncertainty, and ambivalence. One very strong theme, however, was that of the importance of air defense, stimulated in large measure by the growing ability of the MIG OKB to deliver increasingly capable air defense fighters. As the period progressed, Soviet planners came to see the force imbalance that had come of the earlier, disproportionate improvement in air defense. Eventually, air doctrine reemphasized reconnaissance and ground attack, as well as air defense. By the end of the period then, employment concepts began to reflect the possibility of combining nuclear weapons with traditional combined arms doctrine.

### C. 1964-1973, THE NUCLEAR PERIOD

The Soviet theater nuclear offensive, which predominated in the 1964-1973 period, was characterized by the following two propositions: nuclear weapons play the leading role in Soviet theater warfighting capability; escalation is considered highly likely. That is, the Soviet strategy in this time period called for an in-depth, massive, surprise nuclear strike, in conjunction with an immediate high-speed air and ground exploitation.<sup>128</sup> Soviet military doctrine had changed since the 1950's in that the Soviets allowed for the possibility of an "opening conventional phase . . . that subsequently escalates to all-out intercontinental war."<sup>129</sup>

The Soviets' dominant preference in the 1960's was to be able to fight and win a nuclear war in Europe. A "nuclear-oriented Soviet theater doctrine . . . had, as it were, acquired a new lease on life."<sup>130</sup>

---

<sup>127</sup>Wolfe, *Soviet Power*, p. 147.

<sup>128</sup>See Joseph D. Douglass, Jr. *The Soviet Theater Nuclear Offensive* (Washington, D.C.: USGPO, 1976).

<sup>129</sup>Douglass, *Nuclear Offensive*, p. 11.

<sup>130</sup>Wolfe, *Soviet Power*, p. 458.

The Soviet emphasis in the mid- to late-1960's on theater nuclear war is reflected in the number of intermediate-range ballistic missiles (IRBM's) deployed opposite NATO at that time. "By about 1965, the Soviets had over 600 IR/MRBM (intermediate- and medium-range ballistic missile) launchers deployed" and close to 1,000 by 1970.<sup>131</sup> This is the force that would execute the initial nuclear fire barrage (or mass strike) that would have taken place in a Soviet theater nuclear offensive.<sup>132</sup> The second part of such an offensive was to be "rapid exploitation by the ground forces." In fact, "the real heart of the Soviet [theater nuclear offensive was] the ground forces . . . what might be called the exploitation forces."<sup>133</sup> The importance of the ground forces in the theater nuclear offensive reflected the previously-mentioned return to the long-held Soviet preference for combined-arms operations, which had briefly been eclipsed in the Khrushchev years.

The US policy of "Flexible Response," formally adopted during the Kennedy Administration, admitted the possibility of a conventional phase to a European war, but it was based on the assumption of Western military superiority at both the intercontinental and theater-nuclear levels of war. Given this superiority, the West could tolerate inferiority in conventional forces because NATO always retained the flexibility to escalate to a higher level of conflict where dominance (superiority) would be restored. This helps explain why the Soviets perceived escalation in a European war as "inevitable." The Soviet response was to prepare for that escalation; the result was the operational concept for the theater nuclear offensive.

Instead of facing the untenable situation of having only a massive nuclear response to a theater-level nuclear war, the Soviets refined their doctrine and their capabilities for waging war under new conditions. Unlike the US, which did no more than declare its need to be able to fight on "any rung of the escalation ladder,"<sup>134</sup> the Soviets identified early in their debate the essential nature of deterrence and

---

<sup>131</sup> Miller, *Quest for Superiority*, p. 83. Also, Robert P. Berman and John C. Baker, *Soviet Strategic Forces: Requirements and Responses* (Washington, D.C.: The Brookings Institution, 1982), p. 136.

<sup>132</sup> Douglass, *Nuclear Offensive*, p. 45.

<sup>133</sup> Further, "the ground forces, in effect, support or complete the work of the nuclear strike." Douglass, *Nuclear Offensive*, pp. 46-48.

<sup>134</sup> Jeffrey Record, *NATO's Theater Nuclear Force Modernization Program: The Real Issues* (Washington, D.C.: Corporate Press, Inc., 1981), pp. 16-36. Record charges that NATO has failed to establish an operational doctrine for theater nuclear weapons--a failure that he claims persists to this day.

war-fighting. For instance, writing in *Voennaya Mysl'*, two theoreticians wrote in 1968:

A position which in our view is erroneous on the theoretical level and harmful on the practical level is that which<sup>135</sup> counts only on the possibility of preventing war and ignores its being unleashed.

It was in large measure the Soviet concern for a genuine nuclear war-fighting capability that generated the requirement for the theater nuclear offensive. This is not to say that the Soviets wanted a war in Europe, let alone a nuclear war. It is simply that

Soviet doctrine and military posture do not distinguish between deterrent and warfighting nuclear capabilities . . . the better the Soviet armed forces are prepared to fight and win a nuclear war, the more effective they will also be as a deterrent to an attack on the Soviet Union; at the same time, the ability of Soviet forces to fight and win<sup>136</sup> a nuclear war provides indispensable insurance against the failure of deterrence.

Within the context of this increased need to fight a nuclear war, evolving Soviet air employment concepts sought a way to use the aircraft currently in and entering the inventory that would combine traditional combined arms precepts with tactical nuclear weapons. As we have seen, these tended to be fast, high-flying aircraft suited best for the air defense mission, but included as well a recently-acquired (if limited) ground attack capability. Other aircraft, such as the FLOGGER and the FOXBAT had some limited flexibility regarding their employment. For example, the FOXBAT, if it could not be used against the US B-70 for which it was designed, could serve in a more general air defense role, as well as serve as a high-altitude, high-speed reconnaissance platform.

The air employment concept for the theater nuclear offensive emphasized ground attack and reconnaissance missions. The latter included both pre- and post-strike reconnaissance, as well as "armed strike reconnaissance" or "free hunt."<sup>137</sup> The major

---

<sup>135</sup>General Major N. Sushko and Lieutenant Colonel V. Kozlov, "The Development of Marxist-Leninist Teaching on War and the Army," *Voennaya Mysl'*, April 1968, p. 95.

<sup>136</sup>Leon Goure; Foy D. Kohler; and, Mose L. Harvey, *The Role of Nuclear Forces in Current Soviet Strategy* (Miami: Center for Advanced International Studies, University of Miami, 1974), p. 8.

<sup>137</sup>" . . . reconnaissance must now be conducted to a very great depth . . . Aviation can only support tank forces with timely information on the enemy by wide use of the entire complex of modern photo and radiotechnical means, which permit rapid and accurate transmission of reconnaissance information." Col. V. Kuznetsov and Col. B. Andreyev, *Selected Readings from 'Military Thought,' 1963-1973*

mission for frontal aviation was to locate and destroy mobile targets and to identify "new or newly activated airbases."<sup>138</sup> Aircraft were also envisioned as being especially effective when combined with tank forces in deep offensive operations.<sup>139</sup>

The theater nuclear offensive's initial fire barrage was a variation on "suppressive terrain fire," an artillery employment concept that began to lose credibility in the wake of the hard experience of Arab artillery crews in the 1967 and 1973 wars. Subsequently, the Soviets began to shift the focus of their tactical requirements, ending the period of the theater nuclear offensive, and ushering in the theater strategic conventional operation.

#### D. 1973-1985, THE CONVENTIONAL PERIOD

##### 1. Introduction

The Soviets believe that the ever-present threat of uncontrolled escalation to intercontinental nuclear war in the event of a NATO-Warsaw Pact conflict in Europe, as well as improvements in the capability of weapons of all types, particularly aircraft, have made obsolete old forms of conducting warfare. More specifically, the Soviets believe that with greater firepower, longer weapons ranges, faster response times due to automation and computer-assisted decision-making, and with greater mobility, it is increasingly necessary not only to take advantage of scientific and technological developments in order to prosecute the offensive, but it is also increasingly urgent to engage enemy forces (which themselves have increased range, mobility and lethality) throughout the depth of the theater.

In fact, this evolution of weapons capability and its impact on military doctrine is nothing new. Marshal N. V. Ogarkov, former Chief of the Soviet General Staff, described in his 1985 book, *History Teaches Vigilance*, how the organizational structure of armed forces has changed over the centuries. He notes the ever-greater capability of weapons and the subsequent requirement that the organizing principle for their use be changed to reflect more accurately the threat and the capability inherent in the new technologies. He concludes by stating:

---

(Washington, D.C.: USGPO, 1982), p. 127.

<sup>138</sup> Douglass, p. 67.

<sup>139</sup> In combination with tactical and operational missiles, aircraft carrying nuclear weapons were to "clear a path in a short time for tank groupings to swiftly penetrate into the operational depth of a resisting enemy." Kuznetsov and Andreyev, *Selected Readings*, p. 125.

Thus, the creation of new weapons and new military equipment . . . requires corresponding changes in the methods of conducting military operations.<sup>140</sup>

## 2. The Theater Strategic Conventional Operation

The basic field command in the Soviet schema is the front. Presumably because it was a wartime command, the front did not formerly exist in peacetime on a day-to-day basis. The closest Western equivalent to a front is a NATO Army Group. Several fronts comprise a Theater of Military Operations (TVD). It is within the context of these TVD's that the Soviets now do their combat planning, apparently having listened closely to the arguments put forth by Marshal Ogarkov. The 1985 issue of the US Defense Department's 1985 *Soviet Military Power* says:

With the advent of longer range and more capable aircraft and missiles, coupled with increased troop mobility and maneuverability, Soviet concepts for employment of combined arms units and formations are evolving accordingly. The Soviets believe that modern warfare would substantially exceed the framework of front operations. As a result, they envision a larger scale military operation, which they refer to as a theater strategic operation . . . While the Soviet concept of the front as a large combat formation in the field remains essentially intact, the Soviets are now focusing on operations by groups of fronts.<sup>141</sup>

TVD's have in the past, as have fronts, been a wartime organization only. However, in 1979 the Soviets appear to have established the Far Eastern TVD, a major command reorganization probably intended to coordinate the activities of all the Soviet armed forces opposite China and to provide the structure in peacetime that would be necessary for rapid conversion to a wartime footing.<sup>142</sup> Since then, the Soviets have established several peacetime TVD's.<sup>143</sup>

The significance of the peacetime establishment of TVD's is that it may represent the "culmination of a long-standing effort" on the part of the Soviets to streamline their command and control structure.<sup>144</sup> In the past the wartime-only existence of a TVD meant that its creation was indicative of impending hostilities (or

---

<sup>140</sup> Marshal of the Soviet Union N. V. Ogarkov, *Istoriya Uchit Bditel'nosti* (History Teaches Vigilance) (Moscow: Voenizdat, 1985).

<sup>141</sup> US Department of Defense, *Soviet Military Power 1985* (Washington, D.C.: US Government Printing Office, 1985), p. 15.

<sup>142</sup> Berman and Baker, *Soviet Strategic Forces*, p. 13.

<sup>143</sup> *Soviet Military Power 1985*, p. 16. See also *Jane's Defense Weekly* (Surrey: Jane's Publishing Company Limited), 13 April 1985, pp. 623-624.

<sup>144</sup> Michael J. Deane, et al., "The Soviet Command Structure," *Strategic Review*, Spring 1984, p. 66.

at least that the Soviets perceived hostilities to be imminent). For the West, the creation of a TVD may have served as a strategic warning indicator--now that warning would no longer be available. In addition, however, the existence in peacetime of a wartime organization streamlines planning and staff work, and eliminates the problems attendant to passing command at a critical point in time.<sup>145</sup>

Several TVD's comprise a Theater of War (TV). The US Department of Defense (DOD) has identified at least three TV's: Western, Southern, and Far Eastern. The Far Eastern TV appears to be much the same as the Far Eastern TVD; that is, the CINC of the Far Eastern TV may be dual-hatted as the commander of the Far Eastern TVD. A similar situation may exist for the Southern TV and the Southern TVD. The Western TV, however, includes all three TVD's opposite NATO, as well as two oceanic TVD's. Clearly, the commander of the Western TV would be in charge of a tremendous number of forces. His command would include, according to the DOD: 98 Soviet maneuver divisions; 55 non-Soviet Warsaw Pact (NSWP) maneuver divisions; 42,300 tanks; 33,165 artillery, rocket launchers, and mortars (over 100mm); 4,545 tactical aircraft; 1,120 naval combatants (excludes SSBN's); and 1,145 naval aviation aircraft.<sup>146</sup> Thus, the Western TV is the Soviet Union's largest command.

When Marshal Ogarkov assumed new duties in September of 1984, it was widely reported that he had been demoted for one or another transgression. This is hard to believe. Ogarkov presided over the establishment of this new command structure while he was Chief of the General Staff. He had written about it and given speeches on the topic; it is more likely that Ogarkov was never demoted. He may have assumed command of the Western TV, which would explain Georgi Romanov's comment in Helsinki 13 October 1984 that "Marshal Ogarkov commands the Soviet Union's largest western force."<sup>147</sup> In short, the most compelling argument is that after writing about and arguing for reform in the Soviet command structure for several years, and then presiding over the changes, Ogarkov was given the opportunity to command the most important position in the new Soviet command structure.

---

<sup>145</sup>Deane, "Soviet Command Structure," p. 66.

<sup>146</sup>*Soviet Military Power 1985*, pp. 12-14.

<sup>147</sup>Dusko Doder, "Ousted Soviet Chief of Staff Returns to Scene as Author," *Washington Post*, 10 June 1985, pp. 16-17.

One of the most important reasons the Soviets changed their command and control structure was to streamline it, to decrease response time in a crisis. Response time is of critical importance when facing a nuclear threat. Until recently, the dominant assumption in Soviet military doctrine was that nuclear weapons would be used in a European war--if not at the outset, then after a conventional phase of uncertain duration. By 1977, though, when the Soviets began deploying the SS-20 IRBM in significant numbers, NATO no longer had dominance at the theater level. Since then, Soviet doctrinal writings, which had previously assumed that a war would go nuclear because NATO would escalate, have maintained that a European conflict would not necessarily be nuclear.<sup>148</sup> Nevertheless, he does not rule out a nuclear option, for whatever plans the Soviets have for defeating NATO without nuclear weapons, they surely plan for the contingency that NATO will escalate.

In fact, this is a concern that Joseph Douglass addressed when he discussed the theater nuclear offensive. He identified as a major problem for the Soviets the issue of when and how to transition from conventional to nuclear war.<sup>149</sup> This problem remains and, as a result, the Soviets plan to destroy or degrade NATO's nuclear, tactical air and, command and control assets as early in the war as possible. It would fall to the TVD or TV commander to coordinate these diverse combat operations, and in the event, to resolve the dilemma of

abandoning a conventional advantage too soon and not exercising a nuclear option too tardily . . . Contrary to the popular notion of an automatic escalation process, Soviet military writings convey serious attention to a strict set of military preconditions . . . surrounding the decision to escalate.<sup>150</sup>

As CINC of the Western TV, Marshal Ogarkov may be responsible for the command and control of Soviet escalation strategy:

[the] overall organization of their high command is now optimised for the conduct of the non-nuclear strategic deep offensive. [Although there] is little doubt that the final and explicit authorization to use nuclear weapons comes

---

<sup>148</sup>"Conventional war now seems to be the norm, nuclear war the exception." James M. McConnell, *The Soviet Shift in Emphasis from Nuclear to Conventional: The Mid-term Perspective* (Alexandria: Center for Naval Analysis, 1983), CRC 490, Vol. II, p. 27.

<sup>149</sup>Douglass, *Nuclear Offensive*, p. 94.

<sup>150</sup>Dennis M. Gormley and Douglas M. Hart, "Soviet Views on Escalation," *The Washington Quarterly*, Fall 1984, pp. 80-81.

from the Defence Council . . . the hingeing of the entire process of nuclear escalation . . . [on the CINC of the Western TV] should guarantee a relatively smooth transfer from non-nuclear to nuclear war.<sup>151</sup>

To summarize this portion of the argument, it is clear that the realignment of the Soviet command structure is significant for a variety of reasons. One is that it puts the Soviets on a wartime footing in peacetime, which both deprives NATO of an important strategic warning indicator of impending hostilities and also decreases Soviet response time in dealing with crisis situations. Another is that it may provide a focal point for the problems associated with nuclear escalation. Most important for this argument, however, is that the newly-established TVD's and TV's are the command echelons for the exploitation of the newest military technologies, including advanced tactical fighter aircraft. That means that these new combat formations can more effectively make use of greater firepower, longer ranges, greater lethality, and greater mobility. These new command echelons can swiftly execute operations to a depth in the enemy's rear area that could not previously be done by a combined arms commander.

### 3. The Operational Maneuver Group

An important adjunct to these changes in command and control is the renewal of interest in high-speed exploitation forces. The Operational Maneuver Group (OMG) as an outgrowth of the World War II Mobile Group, is designed to energize the attack and "raise the tempo of the advance."<sup>152</sup> If a Soviet commander were able to move a large force, such as an OMG, deep into enemy territory early in the offensive (D+1 or D+2), he would not only make it very difficult for NATO to employ nuclear weapons, but would himself threaten those weapons. The US Department of Defense (DOD) believes the OMG attempts to "impose a theater-wide 'deep battle' and place NATO in just such an untenable position.<sup>153</sup> The widespread improvement and expansion in Soviet helicopter forces provides potential OMG forces with a significant

---

<sup>151</sup>Yossef Bodansky, "Ogarkov Confirmed as Western Theater C-in-C," *Jane's Defence Weekly*, 22 October 1984, p. 716. See also Bodansky, *Jane's Defence Weekly*, 17 August 1985, p. 304.

<sup>152</sup>Christopher Donnelly, "Soviet Operational Concepts in the 1980's," supporting paper to the European Security Study in *Strengthening Conventional Deterrence in Europe: Proposals for the 1980's* (Boston: Nimrod Press, 1983), pp. 105-136.

<sup>153</sup>*Soviet Military Power 1985*, p. 71.

increase in mobility.<sup>154</sup> This application of modern technology helps solve a genuine problem for the Soviets--achieving rapid conventional success under the constant threat of nuclear escalation.<sup>155</sup> Further, if the OMG is taken from the assets of the second echelon, NATO may find its attacks against "follow-on forces" and the second echelon to be in vain.

The appearance of the Operational Maneuver Group clearly represents a significant departure for the Soviet ground forces, which have, since the development of tactical nuclear weapons, been structured and prepared for an "echeloned" battle in Europe. Echeloning provided a way for the Soviets to cease concentrating men and material, and thereby reduce NATO's temptation to strike with nuclear weapons and to reduce the effects of any enemy nuclear fire. Instead of advancing on a broad front and several days later finding, assigning, and executing an operational breakthrough, the Soviets are increasingly interested in achieving their objectives quickly enough to present NATO with a fait accompli.

The Soviets have moved in this direction, despite their prior readiness to execute a theater nuclear offensive, because they

believe it would be difficult to control escalation once the weapons have been used, and therefore they would hope to win without recourse to the nuclear option. In the Soviet view the ability to control the course and outcome of a conflict employing nuclear weapons is, at best, uncertain. The Soviets seek to reduce the uncertainty by managing the degree of freedom of the threat, i.e., NATO's nuclear forces.<sup>156</sup>

The purpose behind the energized attack and advance envisioned by the use of such devices as OMG's is to impose a train of events on NATO faster than NATO can respond, deny NATO time to mobilize, reduce logistics problems for Warsaw Pact forces, and impose minimum damage on captured territory.<sup>157</sup> As an illustration of

---

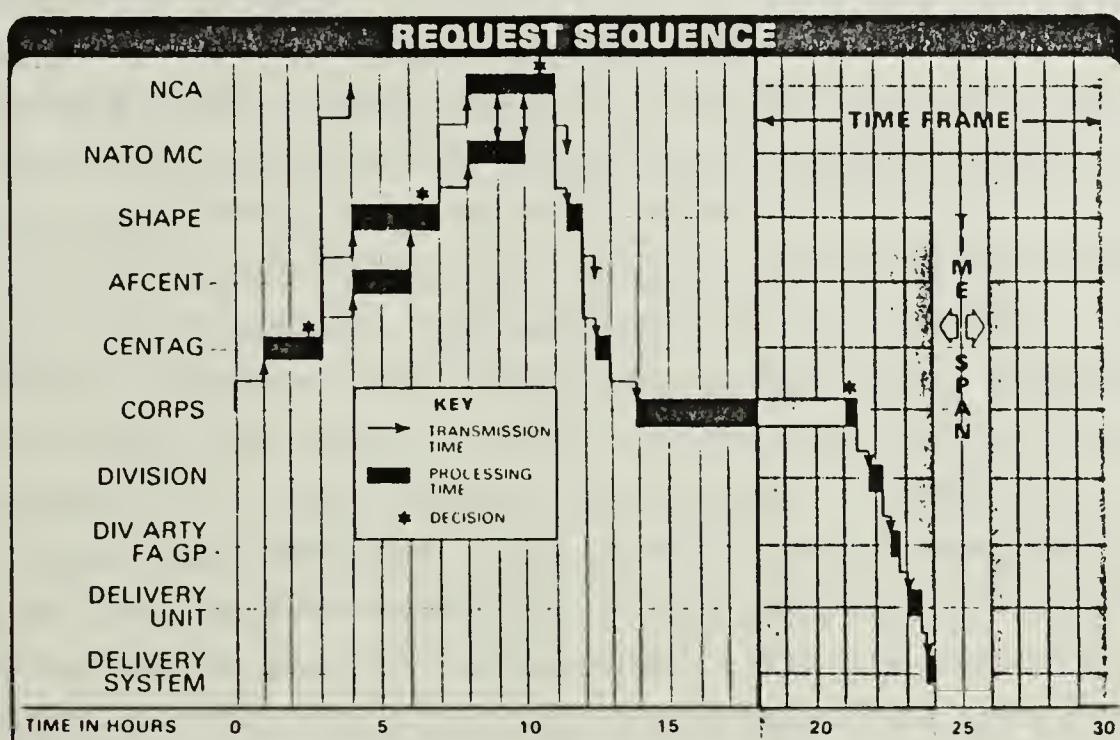
<sup>154</sup>At "Army level about 20 attack regiments have been formed, with up to 60 Hip and Hind attack helicopters each." *Soviet Military Power 1985*, p. 64. The International Institute for Strategic Studies' *The 1985-1986 Military Balance* (pp. 188-191) also says that at Army level there is a helicopter regiment with 40 MI-24 Hind and 24 MI-8 Hip helicopters. In addition, tank and motorized rifle divisions each have a helicopter squadron with six each of Hind and Hip.

<sup>155</sup>Phillip A. Peterson and John G. Hines, "The Conventional Offensive in Soviet Theater Strategy," *Orbis*, Fall 1983, p. 721.

<sup>156</sup>Donnelly, *Strengthening Deterrence*, p. 45.

<sup>157</sup>Donnelly, *Strengthening Deterrence*, p. 46.

how effective the proper execution of the OMG's mission could be, a front-level OMG (committed on the first day of fighting and right behind the leading edges of the first echelon), could seriously disrupt NATO nuclear release procedures. Figure 35, depicts the request sequence for nuclear release authority and its attendant time lapse.



Source: Department of the Army, *Field Manual 100-5* (1977). Quoted in Record, *Force Modernization*, p. 35.

Note: This chart is the best available representation of this request sequence. It may not be completely accurate, but it serves to illustrate the general problem of nuclear release procedures for NATO.

Figure 35. Request Sequence to Fire Nuclear Artillery

It should be clear that, depending on the success of the OMG (and it is by no means certain that the OMG will be successful), it is possible that large, tank-heavy operational raiding forces will be in action deep inside NATO's tactical defenses well before NATO can even decide to respond with nuclear weapons. This use of the OMG represents a sharp departure from past Soviet combat capabilities, in terms of combat formations, depth of mission, and its form of maneuver.<sup>158</sup>

<sup>158</sup>The Soviets have developed two new structures of approximately corps size,

#### 4. The Soviet Air Forces Reorganization

Closely related to both the changes in command and control structures and the development of the OMG is the reorganization of the Soviet Air Forces. In order to understand the significance of the reorganization, it is necessary first to know how the Soviet Air Forces (SAF) were organized prior to the current rationalization.

Reorganization is not new to the SAF. At the beginning of World War II the SAF was comprised of five parts: Long-Range Bomber Aviation; Reserves of the Supreme High Command (VKG); Frontal Aviation; Army Aviation; and Troop Aviation. The confusion that resulted during the opening phases of the war between the USSR and Nazi Germany led the Soviets to simplify their Air Forces into two branches. These were Long-Range Aviation (LRA) (subordinated to the VGK), and the Tactical Air Armies (assigned to the fronts).<sup>159</sup> This arrangement continued until the late 1970's. Beginning in the late 1970's, the Soviets disbanded LRA and the Tactical Air Armies, and restructured part of PVO Strany. Since then, all LRA (bombers) and some Frontal Aviation (tactical) aircraft were organized into five new Strategic Air Armies. The rest of the Frontal Aviation assets and nearly half of PVO Strany's interceptor force were combined into Air Forces of the Military District or Group of Forces. Finally, the helicopters that had been part of Frontal Aviation were separated and reformed into an organization now called Army Aviation.<sup>160</sup>

The current organization of the SAF goes a long way toward helping the Soviets achieve a capability for a successful conventional offensive in Europe. In part, this capability is a function of new technology, but the reorganization is also an attempt to "develop and implement new operational concepts."<sup>161</sup> There is a "pleasing" symmetry evident between the SAF reorganization and the likely concept for Soviet air employment in a war against NATO and the restructuring of the combined arms

---

which are ideal for the OMG mission. DOD says these new corps "contain in excess of 450 tanks, 600 infantry vehicles and armored personnel carriers, and 300 artillery pieces and multiple rocket launchers . . . . Additional units of this type are expected to be formed once testing and evaluation are completed." *Soviet Military Power 1985*, p. 63.

<sup>159</sup> These Tactical Air Armies came to be called Frontal Aviation.

<sup>160</sup> *Soviet Military Power*, p. 81.

<sup>161</sup> "Until Soviet Frontal Aviation began to receive its current generation of aircraft, a Soviet air operation against NATO air and nuclear assets would probably have been ineffective. Soviet tactical aircraft of the 1960's were characterized by light bomb loads and short range. But over the last decade, Soviet units and even units of the non-Soviet Warsaw Pact (NSWP) states, have been equipped with increasingly more capable and sophisticated aircraft." Phillip A. Petersen, "Reorganization Trends," Murphy, *Soviet Air Forces*, p. 267.

command and control structure discussed earlier. That is, the Soviets realize that the role of a particular TVD may change during the course of a war and that the shifting of air power between theaters acquires significant importance. Petersen suggests that in the Western USSR (possibly that geographic area under the control of the CINC of the Western TV) two Strategic Air Armies, normally subordinated to the VGK, could be "allocated" to both the Western and Southwestern TVD's, "with a variable percentage of the longer-range bombers [in another Strategic Air Army] swinging to whichever TVD was perceived by the Supreme High Command [VGK] to have the greatest requirement."<sup>162</sup>

To reconstruct just precisely which air assets would go where, it is necessary to determine which aircraft are in which Air Army. DOD makes it clear that the five Strategic Air Armies of the VGK currently contain the following aircraft: TU-95 BEAR, M-4 BISON, TU-22M BACKFIRE, TU-16 BADGER, TU-22 BLINDER, and SU-24 FENCER.<sup>163</sup> It is also possible that some of these Air Armies control fighter and reconnaissance aircraft.<sup>164</sup> DOD also suggests that the BEAR and BISON aircraft are combined into a single Air Army designed for intercontinental and maritime strikes. Given the intercontinental nature of these missions, it is likely that this would be the Moscow Air Army.<sup>165</sup> It is clear from other sources that the two Air Armies DOD refers to as being comprised entirely of former Frontal Aviation assets are the Legnica and Vinnitsa Air Armies.<sup>166</sup> These are the "FENCER Air Armies."<sup>167</sup> The Smolensk Air Army "controls about 12 bomber bases in the Western Soviet Union, with BACKFIRE, BADGER, and BLINDER assigned."<sup>168</sup> Finally, the Irkutsk Air Army in the Soviet Far East may control BACKFIRE, BADGER and FENCER aircraft.<sup>169</sup> By

---

<sup>162</sup>Col. Yu. Bryukhanov, "The Massed Employment of Aircraft," *Voennaya Mysl'*, June 1969. Quoted in Petersen, "Reorganization Trends," pp. 277 and 340.

<sup>163</sup>*Soviet Military Power*, p. 33.

<sup>164</sup>Petersen, "Reorganization Trends," p. 276.

<sup>165</sup>Petersen, "Reorganization Trends," p. 282.

<sup>166</sup>Petersen, "Reorganization Trends," p. 282. See also the International Institute for Strategic Studies, *The Military Balance: 1985-1986*, pp. 26-27 and William M. Arkin and Richard W. Fieldhouse, *Nuclear Battlefields: Global Links in the Arms Race* (Cambridge: Ballinger Publishing Company, 1985), pp. 263 and 267.

<sup>167</sup>*Soviet Military Power*, p. 34.

<sup>168</sup>Arkin and Fieldhouse, *Global Links*, p. 261.

<sup>169</sup>Arkin and Fieldhouse, *Global Links*, p. 255. It is unlikely that the Irkutsk Air Army controls BEAR or BISON aircraft, as Arkin and Fieldhouse indicate. *Soviet*

dividing up their strategic air assets in this manner, the Soviet would be able to "provide support for specific theaters of military operations [TVD's] and to assure the flexibility to reallocate aircraft as necessary during wartime."<sup>170</sup>

While Soviet strategic air assets can apparently be subordinated from the VGK down to the TV or even the TVD levels, the Air Forces of the Military Districts and the Groups of Forces are designed primarily to be used by the front commander, as frontal aviation.<sup>171</sup> These aircraft would execute a wide range of missions, including air defense cover, reconnaissance, ground support, and interdiction. These valuable contributions notwithstanding, the Soviets understand air superiority to be an absolutely essential condition for victory in war. The Soviets, therefore, intend to attain air superiority through the execution of a theater-wide strike of massive proportions at the very outset of a war in Europe. Because this air operation would be so critical to the Warsaw Pact's success,

[most], if not all, of the aviation assigned to the combined arms fronts [i.e., the Air Forces of the Military Districts/GOF] in a given theater of military operations must initially support the overall theater air [operation].<sup>172</sup>

The requirement that front-level fixed-wing aircraft participate in the theater-wide air operation at the beginning of the war deprives the maneuver formations of their support for an indefinite period of time. As a result, the Soviets have greatly expanded the role of helicopters, separating them from the former Frontal Aviation organization, and aggregating them together into the newly formed Army Aviation. There are a variety of reasons that the Soviets prefer helicopters over high-performance fixed-wing aircraft for the "close air support" mission. These include

---

*Military Power 1985*, makes clear that only one Air Army is designed for intercontinental strike, and it is more reasonable to suppose that it is the Moscow Air Army that has this responsibility. In addition, it is possible, since there are FENCER's in the Far East, that Irkutsk controls some of these relatively new tactical bombers, performing in the Far East the functions of the Smolensk, Legnica and Vinnitsa Air Armies in the West.

<sup>170</sup> *Soviet Military Power 1985*, p. 33.

<sup>171</sup> Military Districts and Groups of Forces typically become fronts in time of war.

<sup>172</sup> Petersen and Hines, "Conventional Offensive," p. 713.

fewer logistics problems, deployment closer to the forward edge of the battle area, and improved capability to conduct reconnaissance. In addition, like fixed-wing aircraft, helicopters can both concentrate and disperse rapidly.<sup>173</sup>

Overall, the SAF reorganization has resulted in a command and control structure for air assets which makes them more responsive to requirements at every command echelon. At the strategic level (greater than 500 km) the VGK, TV, and TVD commands have long-range air assets that can be used to execute the air operation at the outset of a war, and can later be progressively "allocated" to subordinate commanders on critical axes of advance within the theater of military operations. At the operational levels (100 km to 500 km), front commanders have fixed-wing air assets which will probably be relinquished to higher authorities at the outset of a war, but which, after the air operation, will be "returned" for the support of front level objectives. In addition, the front commander now has control not only of former Frontal Aviation tactical aircraft, but also a large number of former PVO Strany air defense interceptors. These can be used to enhance the front's air defenses when necessary, as well as perform other missions, such as limited ground attack and reconnaissance. In the meantime, the front's subordinate combat maneuver formations will not have been without air support; at the tactical level (up to 100 km), division, army and front commanders have a great many attack helicopters (and perhaps eventually get the SU-25 FROGFOOT ground support fighter) in the new Army Aviation organization.

Soviet writers frequently extol the virtues of aerial fire support. They recognized that the command and control structure that existed prior to about 1980 was not flexible or responsive enough to meet the needs of their evolving operational concepts. Specifically, the old LRA structure was too cumbersome to accomplish the important missions in depth that might suddenly arise during combat, such as destroying recently discovered enemy nuclear weapons or concentrations of enemy aircraft. Also, the previous generation of fighters and fighter-bombers did not have the range or payload capability to effectively establish fire superiority in general, or air

---

<sup>173</sup>"In order to free aviation of the front to participate in deep attacks in a theater of military operations, helicopters would have to assume much of the responsibility for aerial fire support of the ground forces. The resurrection of 'army aviation' suggests that the Soviets have found a solution to the problems involved in conducting deep-theater strikes in support of the TVD objectives while at the same time providing direct air support to the ground forces." Petersen, "Reorganization Trends," p. 274.

superiority in particular. The realignment of air assets, such as FENCER and BACKFIRE, into Air Armies of the VGK centralized their control and

made it possible to broadly maneuver aviation, to quickly create powerful aviation groupings on the major strategic sectors, and sharply alter the ratio of forces in favor of Soviet aviation.<sup>174</sup>

Centralized control also eases the airspace management problem. The subordination of former PVO interceptors to front commanders is a recognition that offense and defense in the forward edge of the battle area (FEBA) are too intimately related to each other to be separated administratively. It may also represent a growing appreciation for the exceedingly high cost of "single-mission aircraft" and the gradual development of Soviet aircraft design to the point where a particular airframe may effectively perform multiple missions.

Finally, the development of Army Aviation is clearly an attempt to redress the organizational absence of a necessary combat capability: that of providing direct, closely controlled, responsive ground support to maneuver formations. Combined arms commanders now have dedicated air assets organized in a structure that closely resembles the wartime structure of the ground forces themselves.

The reorganization has been driven by the increased ranges, accuracy, and speed of weapons--not only was it possible to deliver strikes at tremendous depth and with impressive accuracy, but it also became increasingly urgent to do so because the adversary had much the same capability. The reserve Air Armies of the VGK are created from former LRA and some former Frontal Aviation assets. They are specifically designed to provide flexible firepower to TV/TVD combined arms commanders and, when they can be spared, to front commanders who need the extra air support because their advance lies on the theater's main axis of advance.

Army Aviation is made of the old Frontal Aviation helicopters and possibly the SU-25 FROGFOOT ground support fighter. Army Aviation appears to allocate to front commanders two regiments of attack helicopters; armies now have one such

---

<sup>174</sup>N. Dagayev and V. Chernitskiy, "Trends in the Development of the Organizational Forms of Frontal and Long-Range Aviation During the Great Patriotic War," *Voyenno-Istoricheskiy Zhurnal*, October 1980.

regiment assigned, and motorized rifle and tank divisions each have a squadron of helicopters assigned. These are organic fire support units, dedicated to the close air support mission.

Aircraft which previously had been controlled only at the national level (such as BACKFIRE) appear now to be "available" to the combined arms commander at the TV/TVD level, significantly increasing the reach of aerial firepower in the theater of war and the theaters of military operations. Also, the maneuvering of air assets from one TVD to another, between levels of command (such as would be the case when a TVD commander appropriates tactical air assets from his subordinate front commanders to carry out theater-level objectives), and between fronts themselves, is much easier. The principle is that each command echelon has its own "dedicated" air assets that can be used in support of "unique" combat objectives, however, a superior commander has the authority to requisition aircraft to accomplish the objectives of a higher command echelon, or to adjudicate the disputes that would inevitably arise between coordinate commands as to the additional air assets to which they are entitled. For example, a TVD commander would determine if one of his subordinate front commanders, operating on a secondary axis within the TVD, should relinquish his air assets to an adjacent front, which lies on the main axis of advance and is in a breakthrough position. Another form of maneuver is that envisioned by transferring the assets of an entire Air Army from one TVD to another. An example might be the deployment of Vinnitsa Air Army assets from the Southwestern TVD (opposite Turkey, Greece, and Italy) to the Western TVD (opposite Germany), where they would augment the efforts of the Legnica Air Army.

##### 5. The Air Operation

Throughout the period during which the theater nuclear offensive was the dominant operational concept for continental land warfare, the Soviets were compelled to keep their forces dispersed. This was one of the purposes of echeloning, the first echelon of which was essentially the nuclear strike itself. The rapid development of aircraft and missile capability permitted replacement of the nuclear fire barrage with a conventional fire plan whose effects would be great enough to both neutralize NATO's air assets and destroy NATO's nuclear weapons, thus establishing general fire superiority over NATO. The vehicle for the conventional fire plan is the "air operation," the post-WW II effectiveness of which was demonstrated in the 1967 Israeli strike on Egyptian, Syrian and Jordanian airfields at the outset of the Six-Day War.

The air operation is expected to last several days. During that period, there would be only limited ground support available to maneuver formations, while most fixed-wing assets (except those on nuclear-withhold) would be engaged in phased wave attacks on NATO airfields, nuclear storage, and command and control facilities. The device for reducing aircraft losses in NATO's air defense environment is the "air corridor;" one or two of which would be established per front.<sup>175</sup> These penetration corridors would be created through the execution of a highly structured series of phased attacks on NATO's air defense system. These integrated attacks would be made against radars, missile sites, airfields, and command and control facilities, and would include extensive stand-off-, escort-, and self-protection jamming and electronic deception. The progression of the attack after the first waves would be highly dependent on tactical reconnaissance and battle damage assessment. After the corridors are opened and NATO's air and nuclear assets have been sufficiently neutralized to prevent escalation and blunting of the Warsaw Pact offensive, fixed-wing assets would be progressively released back to the fronts for ground support duties and front-level objectives. Because the Soviets realize that 50 percent of NATO's firepower rests with NATO air assets, successful execution of the air operation is necessary for establishing fire superiority early in the war and is, in fact, the linchpin of current Soviet doctrine. With a thorough look at the evolution of both Soviet fighter design and Soviet air employment doctrine now complete, we can turn to a more rigorous analysis of the interaction between the two. That effort is undertaken in the next section.

---

<sup>175</sup>Col. Aleksander Musial, "The Character and the Importance of Air Operations in Modern Warfare," *Polish Air and Air Defense Review*, 1982, p. 12. Quoted in Phillip A. Petersen and Major John R. Clark, "Soviet Air and Antiair Operations," *Air University Review*, March-April 1985, Vol. 36, no. 3, pp. 36-54.

## V. QUANTIFYING THE PROBLEM

### A. THE COMPONENTS OF FIGHTER CAPABILITY

This section of the thesis seeks to quantify the evolution of Soviet fighter aircraft technology and air employment doctrine. The purpose is to more systematically and objectively measure their covariation and assess their relationship to each other. Of the 80 variables in the data base, 10 were chosen for the factor analysis. These 10 variables, presented in Table I (next page), appeared in earlier explorations of the data to best describe the evolution of fighter technology.<sup>176</sup> They have the virtue of reflecting the importance of the weapons and avionics suites, rather than just the physical characteristics of the airframe and its propulsion system. The design of the aircraft itself is important, to be sure, but, as was shown earlier, the most significant changes to date in that area were the adoption of the swept wing and jet propulsion in the last days of the World War II and the immediate postwar years. Since then, the biggest changes have been in the fields of weapons and aviation electronics (avionics).

Thus, this selection of ten variables is designed to illuminate precisely those areas that have experienced the maximum growth and development over the past forty years. The maneuverability variable, however, does capture a number of important features of the airframe and its propulsion system, and stands as an adequate surrogate for more exact measures of maneuverability.<sup>177</sup> In addition, it seemed that these ten variables would accurately describe the two basic dimensions of the Soviet fighter force, air combat and ground attack. Finally, this particular combination resulted in the fewest factors accounting for the maximum variation in the observations.

The purpose of this Q-factor analysis<sup>178</sup> was to identify two profiles of aircraft: air combat (AA) and ground attack (GA). Characteristics common to AA fighters should cluster together on an "AA dimension," while characteristics common to GA

---

<sup>176</sup>See Appendix A for a more complete description of the data base.

<sup>177</sup>Turn rate and specific excess power for Soviet fighters have not been found in open source materials.

<sup>178</sup>Factor analysis applied to units (individuals, nations, aircraft, etc.) is Q-factor analysis; the intent is to detect patterns of profile similarity. R-factor analysis, more common, is based on correlations between variables.

TABLE I  
LIST OF VARIABLES USED IN FACTOR ANALYSIS

<u>NAME OF VARIABLE</u>	<u>DESCRIBES</u>	<u>COMMENTS</u>
TRACK	air intercept radar track range	
SEARCH	air intercept radar search range	
MSLRANGE	maximum air-to-air missile (AAM) range	
NUMBERMSLS	maximum number of AAM's	
CRADIUS	combat radius	for air combat, subsonic area intercept; for ground attack, HI-LD-HI and 50% ordnance
TWRATIO	thrust-to-weight ratio	maximum after-burning thrust divided by combat weight (50% fuel and 100% ordnance)
MANEUVER	maneuverability	ratio of TWRATIO to combat wingloading (combat weight divided by wing area)
ORDNANCE	maximum weight of ground attack ordnance	
GUNS	number of guns	
STATIONS	number of weapons pylons	

aircraft should cluster together on a "GA dimension" at a right angle (orthogonally) to the air combat fighters. Table II (next page) presents the correlation matrix input for the factor analysis.

Table III (page 95) presents the estimates of communality, which describe the variation in one variable that can be expected from the shared influence of all the other

TABLE II

## CORRELATION COEFFICIENTS FOR FIGHTER MATRIX (FTRMAT)

	TRACK	SEARCH	MSLRANGE	NUMBERMSLS	CRADIUS	TWRATIO	MANEUVER	ORDNANCE	GUNS	STATIONS
TRACK	1.00000	.95145	.90950	.66667	.70631	.47199	.10634	.13728	-.36664	.17647
SEARCH	.93845	1.00000	.91401	.70920	.62193	.50627	.10351	.12798	-.07070	.17034
MSLRANGE	.90850	.91401	1.00000	.75785	.70747	.39615	-.06869	.15927	-.53215	.29574
NUMBERMSLS	.66667	.70920	.75785	1.00000	.48728	.42032	-.06128	.24922	-.62880	.40426
CRADIUS	.70631	.69153	.70747	.48728	1.00000	.35831	-.21352	.51355	-.42641	.29561
TWRATIO	.47199	.50627	.39615	.42033	.35831	1.00000	.60632	-.01274	-.25860	-.02912
MANEUVER	.10634	.13051	-.06869	-.06128	-.21352	.60632	1.00000	-.51296	.27841	-.37295
ORDNANCE	.13728	.12798	.15927	.24922	.51355	-.01274	-.51295	1.00000	-.10458	.78719
GUNS	-.36664	-.37373	-.53215	-.51355	-.42641	-.25860	.27841	-.10492	1.00000	-.03749
STATIONS	.17647	.17034	.29574	.40426	.29551	-.02923	-.37395	.78719	-.03746	1.00000

variables. Table IV (next page) presents the results of the factor delineation. It shows that all of the variance can be accounted for by nine linear combinations of these factors, and that over 82% can be accounted for by just three factors (factor matrices in Tables V and VI, page 95).

The final varimax-rotated factor matrix in Table VI shows the three vectors and their highest loadings. The first factor (Long Kill) is the long-range kill capability of Soviet air combat fighters. One would expect a high positive correlation between the derived variable (Long Kill), which would require long-range radar detection and tracking, long-range AAM's and multishot capability, and high values for the variables SEARCH, TRACK, MSLRANGE, and NUMBERMSLS. This factor alone accounts for nearly half of the observed variance in Soviet fighter capability. It reflects the long-standing Soviet penchant for ground-controlled intercept (GCI) vectoring of air defense fighters for a single-pass shot and subsequent return to base. It also reflects the more recent design of first-look, first-shot, beyond-visual-range (BVR) kill capabilities.

The second derived factor (Ground Attack) loads most heavily on ordnance-carrying capability and the number of weapons pylons. Factor 2 accounts for another 23% of the observed variance. Finally, Factor 3 loads heaviest on maneuverability and thrust-to-weight ratio. These are characteristics primarily of the

TABLE III  
ESTIMATES OF COMMUNALITY

<u>VARIABLE</u>	<u>COMMUNALITY</u>
TRACK	.88151
SEARCH	.90418
MSLRANGE	.89915
NUMBERMSLS	.72512
CRADIUS	.69274
TWRATIO	.73179
MANEUVER	.92868
ORDNANCE	.90182
GUNS	.73063
STATIONS	.84137

TABLE IV  
FACTOR DELINEATION

<u>FACTOR</u>	<u>EIGENVALUE</u>	<u>PERCENT VARIATION</u>	<u>CUMULATIVE PERCENT</u>
1	4.83068	48.3	48.3
2	2.99995	23.0	71.3
3	1.10636	11.1	82.4
4	.76276	7.6	90.0
5	.59246	5.9	95.9
6	.13121	1.3	97.2
7	.12097	1.2	98.4
8	.10585	1.1	99.5
9	.04506	.5	100.0
10	.00469	.0	100.0

TABLE V  
UNROTATED FACTOR MATRIX

	<u>FACTOR 1</u>	<u>FACTOR 2</u>	<u>FACTOR 3</u>
TRACK	.935002		
SEARCH	.917237		
MSLRANGE	.911214		
NUMBERMSLS	.844122		
CRADIUS	.811555		
STATIONS		.852959	
MANEUVER		-.784461	
GUNS		-.699740	
ORDNANCE		.560274	
TWRATIO			.615255
GUNS			.451479
STATIONS			.443761
MANEUVER			.386225

TABLE VI  
FINAL VARIMAX-ROTATED FACTOR MATRIX

	<u>FACTOR 1</u> <u>LONG KILL (AA)</u>	<u>FACTOR 2</u> <u>GROUND ATTACK</u>	<u>FACTOR 3</u> <u>CLOSE KILL (AA)</u>
MSLRANGE	.937756		
SEARCH	.897850		
TRACK	.890637		
NUMBERMSLS	.830859		
CRADIUS	.732850		
ORDNANCE		.920494	
STATIONS		.902270	
MANEUVER			.886082
TWRATIO			.711325
GUNS			.421414

airframe and propulsion system, however, the number of guns loaded third-highest on this factor so it has been labelled "Close Kill." The close kill capability of an aircraft is in fact a function of its maneuverability, ability to accelerate, and the number and quality of its short-range weapons, particularly its guns. This third factor, Close Kill, describes that small portion of the Soviet fighter force characterized by apparently good abilities in hard-turning, close-in air engagements. While it corresponds to "dogfight" capability, it remains to be seen if this latent capability will be exploited by Soviet pilots and planners.

This factor analysis shows that there are actually three dimensions to Soviet fighter capability: two of these relate to air combat (Long Kill and Close Kill); another describes the ground attack role. This factor analysis will help define the framework for the multi-attribute utility analysis of Soviet fighters and employment doctrine presented next. It is clear that any such model should incorporate three elements: long- and close-range kill in air-to-air combat, and ground attack capability.

## B. SCORING SOVIET FIGHTER TECHNOLOGY AND DOCTRINE

The multi-attribute utility analysis undertaken in this section uses the framework developed by the factor analysis. The model here is specifically designed to emphasize the growth in those performance characteristics highlighted by the factor analysis as significant to particular mission orientations. In essence, each aircraft in the data base was given a raw score according to the equation appropriate for its mission category. That raw score was converted into a "technological index" by dividing it by the raw score of the lowest-scoring aircraft in the same mission category (the baseline aircraft). *This index of embodied technology is not a measure of combat capability, per se.* It measures the relative position of aircraft in the same mission category with respect to the technical component of aircraft performance. This technical component is a source of potential combat capability that may or may not be tapped by the pilot or the planners who develop employment techniques. In any event, it is by no means established that the technological level of a fighter aircraft is the best indicator of its combat potential (this issue will be addressed in the final section of this thesis); it may only be the most visible and measurable.

With this disclaimer, recall that long-range kill capability is characterized by long-range air intercept radars, long-range missiles, and a multishot capability. This combination of requirements is characteristic of Soviet air defense fighters assigned to

the national air defense organization (PVO). These air defense fighters include the SU-9 FISHPOT B, SU-11 FISHPOT C, SU-15 FLAGON series (A, D, E and F), MIG-25 FOXBAT A and E, and the MIG-31 FOXHOUND. The following equation was used to derive a raw air combat score for these nine aircraft:

$$[(\text{NUMBERMSLS})(\text{MSLRANGE}) + \text{TRACK}] \times \text{CRADIUS} = \text{RAW SCORE}$$

Each raw score was then divided by that of the baseline aircraft (SU-9 FISHPOT B) to derive an index of incorporated air-to-air technology for these air defense interceptors. Table VII presents these air combat technological index values (TINDEXA).

TABLE VII  
TINDEXA VALUES FOR AIR DEFENSE INTERCEPTORS

<u>AIRCRAFT</u>	<u>TINDEXA</u>
SU-9 FISHPOT B	1.00
SU-11 FISHPOT C	1.46
SU-15 FLAGON A/D	2.65
SU-15 FLAGON E/F	3.17
MIG-25 FOXBAT A	7.51
MIG-25 FOXBAT E	9.77
MIG-31 FOXHOUND	58.25

The second component of air combat capability is the close-in kill, characterized by maneuverability and short-range weapons. This element was added to the basic TINDEXA equation as follows:

$$\{[(\text{NUMBERMSLS})(\text{MSLRANGE}) + \text{TRACK}] + [\text{MANEUVER} + \text{GUNS}]\} \times \text{CRADIUS}$$

This equation, which included both long-range and short-range kill capability, was used to derive raw scores for all the other air-to-air fighters (air superiority) in the data base. These scores were indexed according to the first MIG-15 FAGOT, as shown in Table VIII (next page).

TABLE VIII  
TINDEXA VALUES FOR AIR SUPERIORITY FIGHTERS

<u>AIRCRAFT</u>	<u>TINDEXA</u>
MIG-15 FAGOT	1.00
MIG-15 FAGOT	1.44
MIG-17 FRESCO A	1.54
MIG-17 FRESCO B	1.54
MIG-17 FRESCO C	1.78
MIG-17 FRESCO D	1.66
MIG-17 FRESCO E	2.89
MIG-19 FARMER A	1.91
MIG-19 FARMER B	2.02
MIG-19 FARMER C	2.02
MIG-19 FARMER D	1.82
MIG-19 FARMER E	3.15
MIG-21 FISHBED A	2.19
MIG-21 FISHBED C	2.30
MIG-21 FISHBED D	3.04
MIG-21 FISHBED F	2.93
MIG-21 FISHBED H	6.07
MIG-21 FISHBED J	6.18
MIG-21 FISHBED K	6.13
MIG-21 FISHBED L	6.03
MIG-21 FISHBED N	6.19
MIG-23 FLOGGER A	23.62
MIG-23 FLOGGER B	24.36
MIG-23 FLOGGER G	25.53
MIG-29 FULCRUM	46.27
SU-27 FLANKER	91.19

Because most aircraft are able to function in a capacity outside of their primary mission (however, poorly), ground attack aircraft have some small air-to-air capability. As a result, TINDEXA scores were derived for all Soviet fighters in the data base, in order to develop average TINDEXA values for each time period under consideration. Figure 36 presents the postwar evolution of TINDEXA values, while Table IX shows the average TINDEXA for each time period (page 100). These figures suggest that while there were improvements in air combat capability in all periods, the greatest increase came in period four and the smallest came in period three.

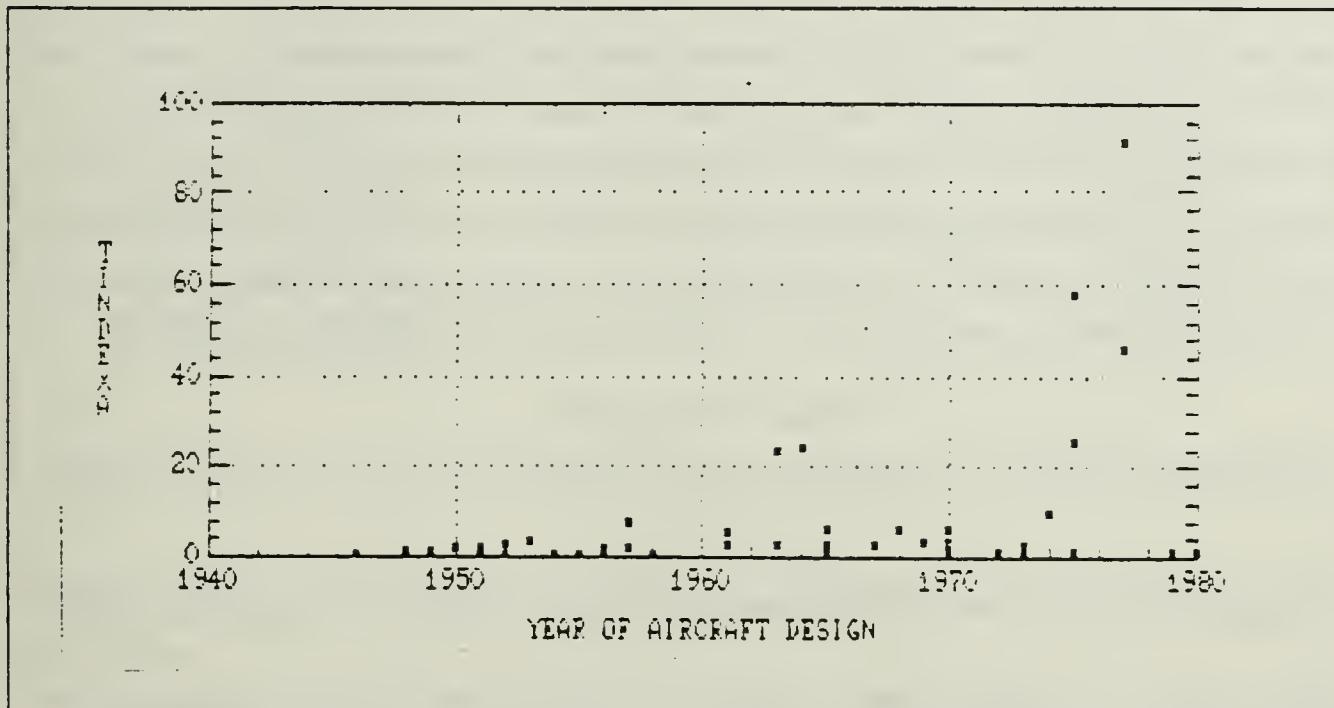


Figure 36. Evolution of TINDEXA

TABLE IX  
AVERAGE TINDEXA VALUES

<u>1945-1953</u>	<u>1954-1964</u>	<u>1964-1973</u>	<u>1973-1985</u>
1.89	4.16	5.15	21.80

The second dimension of Soviet fighter capability is the ground attack mission, the most important indicators of which were shown to be ordnance-carrying capability (ORDNANCE) and number of weapons pylons (STATIONS). The latter is an important addition to ORDNANCE because it represents the flexibility with which various types of targets can be attacked, as well as the potential number of targets that can be attacked. Also, because precision-guided munitions (PGM's) are so much more accurate than "conventional" munitions, PGM-capable aircraft include a constant that doubles the ORDNANCE contribution to their raw score. This considerably understates the improvement force planners can expect when calculating damage done by PGM's compared to older "dumb" bombs, so there is no threat of the raw scores or the subsequent index values overstating the improvement in ground attack capability in recent years. In addition, sea-level maximum airspeed (MACHSL) and combat radius (CRADIUS) were included to help describe the ground attack aircraft's survivability and depth of operation, respectively. The ground attack equations were as follows:

if not PGM-capable:

$$[(\text{ORDNANCE})(.01) + \text{STATIONS}] (\text{MACHSL})(\text{CRADIUS}) = \text{RAW SCORE}$$

if PGM-capable:

$$[(\text{ORDNANCE})(.02) + \text{STATIONS}] (\text{MACHSL})(\text{CRADIUS}) = \text{RAW SCORE}$$

Ground attack technological index values (TINDEXG) were derived in the same way as TINDEXA values, except that the baseline aircraft was the SU-7 FITTER A. Table X (page 101) presents these TINDEXG values.

As with the TINDEXA values, TINDEXG values were also calculated for the air-to-air fighters. Figure 37 and Table XI show the evolution of TINDEXG and both TINDEX averages in each time period (page 102). They show that the largest increase in ground attack capability came in Period III, during which time air combat capability increased at its slowest rate. These values confirm that Period III can be characterized as a "ground attack period," while Period IV can be characterized as an "air combat period." The first Period, during which the MIG OKB was the sole designer of fighter aircraft included in this study, was characterized by designs which flew faster and higher than their predecessors--primarily air defense fighters poorly suited to the ground attack role. The second period's TINDEX values show continued improvement in air combat capability, while the tenfold increase in TINDEXG reflects SUKHOI's reentry into the design community, notably with the SU-7 FITTER ground attack series.

TABLE X  
TINDEXG VALUES FOR GROUND ATTACK FIGHTERS

<u>AIRCRAFT</u>	<u>TINDEXG</u>
SU-7 FITTER A	1.00
SU-7 FITTER B	2.00
SU-7 FITTER	2.00
SU-17 FITTER C	4.20
SU-17 FITTER D	8.42
SU-17 FITTER H	9.54
SU-17 FITTER K	9.54
SU-24 FENCER A	54.57
SU-24 FENCER B	54.57
SU-24 FENCER C	54.57
SU-24 FENCER D	54.57
SU-25 FROGFOOT	4.55
MIG-27 FLOGGER D	8.72
MIG-27 FLOGGER J	8.72

SUKHOI's reentry into the design community, notably with the SU-7 FITTER ground attack series.

An aircraft's depth of operation is captured in this study by combat radius (CRADIUS), which measures the maximum distance from the aircraft's home base at which it can carry out its combat mission and return to the base from which it took off. This relationship of the locus of combat to the locus of basing is an important measure of aircraft capability, but it says nothing about the type of mission the aircraft is supposed to accomplish. A better indicator of the latter is the relationship of combat radius to the depth of responsibility corresponding to the command echelon that controls the aircraft. Thus, a ratio of unity means that the aircraft is capable of operating at a distance that exactly corresponds to the controlling echelon's maximum depth of responsibility. If this variable (DEPTHRATIO) is less than one, the aircraft will constantly be under the control of the owning command. When the DEPTHRATIO is greater than one, the aircraft will either "chop" to a higher echelon of command (which would have a correspondingly greater depth of responsibility) or

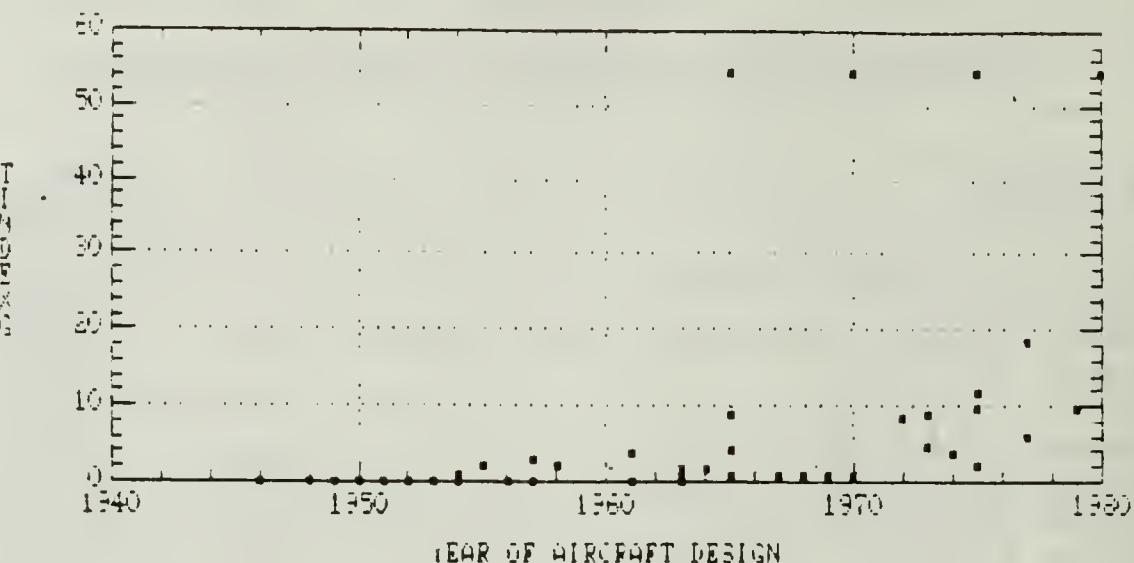


Figure 37. Evolution of TINDEXG

TABLE XI  
DISAGGREGATED TINDEX VALUES

	<u>1945-1953</u>	<u>1954-1964</u>	<u>1964-1973</u>	<u>1973-1985</u>
GA	.18	1.16	9.89	16.66
AA	1.89	4.16	5.15	21.80

exercise a degree of autonomy, and possibly initiative, greater than that of aircraft operating within their command's depth of responsibility. Once DEPTH RATIO values are established for each aircraft it is possible to average the scores for each period and to characterize each period accordingly (see Table XIII, page 104).

TABLE XII  
DEPTHRATIO-MISSION RELATIONSHIPS

Depthratio	Air Combat		Ground Attack
	Air Defense	Air Superiority	
.5	Point Air Defense		
1.00 FEBA	Perimeter Air Defense		
1.3J	Long-Range Air Defense and Anti-Standoff Platform Missions	Battlefield Air Superiority	Close Air Support Ground Attack and Battlefield Air Interdiction
1.87			Interdiction
2.30		Offensive Counter Air and Escort	Deep Strike

The orientation of the DEPTH RATIO scale above makes clear that certain missions must coincide with others if they are to be effective. For example, effective close air support missions require correspondingly effective action in the battlefield air superiority role. Similarly, effective offensive counterair (OCA) strikes in the absence of ground support missions run the risk of rendering the "air war" irrelevant to the outcome of the larger combined-arms battle. The most effective force development demands a good mix of air combat and ground attack capabilities.

TABLE XIII  
DISAGREGGATED AVERAGE DEPTH RATIO VALUES BY PERIOD

	<u>1945-1953</u>	<u>1954-1964</u>	<u>1964-1973</u>	<u>1973-1985</u>
AA	.40	.54	1.23	1.71
GA	---	1.25	2.36	2.24

Seen in this light, Soviet fighter development has exhibited periods of growth in one or another dimension of this idealized force mix. The larger of the two DEPTH RATIO values in each time period dictate the maximum depth of operation the fighter force can undertake. The greater the disparity between the two values, the greater the imbalance in the fighter force and its doctrinal orientation. For example, in Period II, the ground attack component of the fighter force was able to undertake close air support missions, but the air combat component was capable only of shallow air defense missions. This would have left the ground attack missions without protective top cover. Although air combat capability improved in each of the following period, it still did not keep up with the improvements in the ground attack component.

In Period IV, the reorganization of the Soviet air forces slightly reduced the DEPTH RATIO values for the ground attack component by resubordinating some aircraft to higher command echelons (this has the effect of increasing the size of the DEPTH RATIO denominator). In addition, the air combat DEPTH RATIO values continued to increase, reducing still further the indicator of force imbalance. As this trend continues, the Soviet fighter force will theoretically be increasingly capable, technically, of carrying out effective mission (both air superiority and ground attack) well beyond the FEBA.

Figure 38 (page 106). graphically illustrates the sharp disparity between Soviet doctrinal requirements throughout the postwar period and the ability of the Soviet fighter force to carry out such missions. The X- and Y-axes present ground attack and air combat DEPTH RATIO values, respectively. The four curves correspond to the doctrinal orientation of each of the four periods. They depict the requirement of

values for the particular period. The straight lines depict actual fighter force capability at the time (determined by the average AA and GA DEPTH RATIO values in that time period). Perfect convergence between doctrine and capability would show up as an arc (doctrine), whose ends are connected by a straight line (capability). Deficiencies in capability (relative to doctrinal requirements) are shown as gaps between the arc's ends and the capability line (and highlighted by brackets).

The first postwar period was one of Stalinist domination. The prevailing doctrine of the period echoed Soviet World War II experience. In terms of air employment doctrine, the Soviet said they intended to use air assets in a ground attack role. There were envisioned no air actions independent of the ground forces' operations. Technological development of the period, however, was not oriented toward ground attack aircraft. In fact, the increasing wing sweep, lower aspect ratios and thinner airfoil sections of Soviet fighters under development at the time were intended to provide aircraft that flew higher and faster than their predecessors. They were clearly optimized for the air defense role and had virtually no ability to execute ground attack missions.

In the second period, after its reestablishment, one of SUKHOI's first designs was the SU-7 FITTER ground attack fighter. This aircraft remedied the serious ground attack deficiency in Period I. In fact, ground attack capability improved so much that an imbalance was created in the air combat dimension. Specifically, the Soviets were now able to carry out ground attack missions at the FEBA, transforming the Soviet fighter force from one oriented toward point air defense into one oriented ostensibly toward offensive operations. But now there was a deficiency in the air combat role, which was still restricted to air defense.

In Period III both air combat and ground attack capabilities improved. For the first time, Soviet air combat capability moved out beyond the FEBA and into the battlefield air superiority arena. Actual air combat capability, however, was just slightly greater than would have been necessary to meet the doctrinal requirements of the earlier period. Again, SUKHOI ground attack aircraft (SU-17 FITTER and SU-24 FENCER) "drove" the doctrinal requirements out still further, both reflecting and ramifying the development in the 1960's of the Soviets' theater nuclear offensive concept, which married traditional Soviet combined-arms doctrine with the realities of the modern nuclear battlefield. Since ground attack aircraft were now capable of interdiction and deep strike missions (while air combat fighters were still restricted to

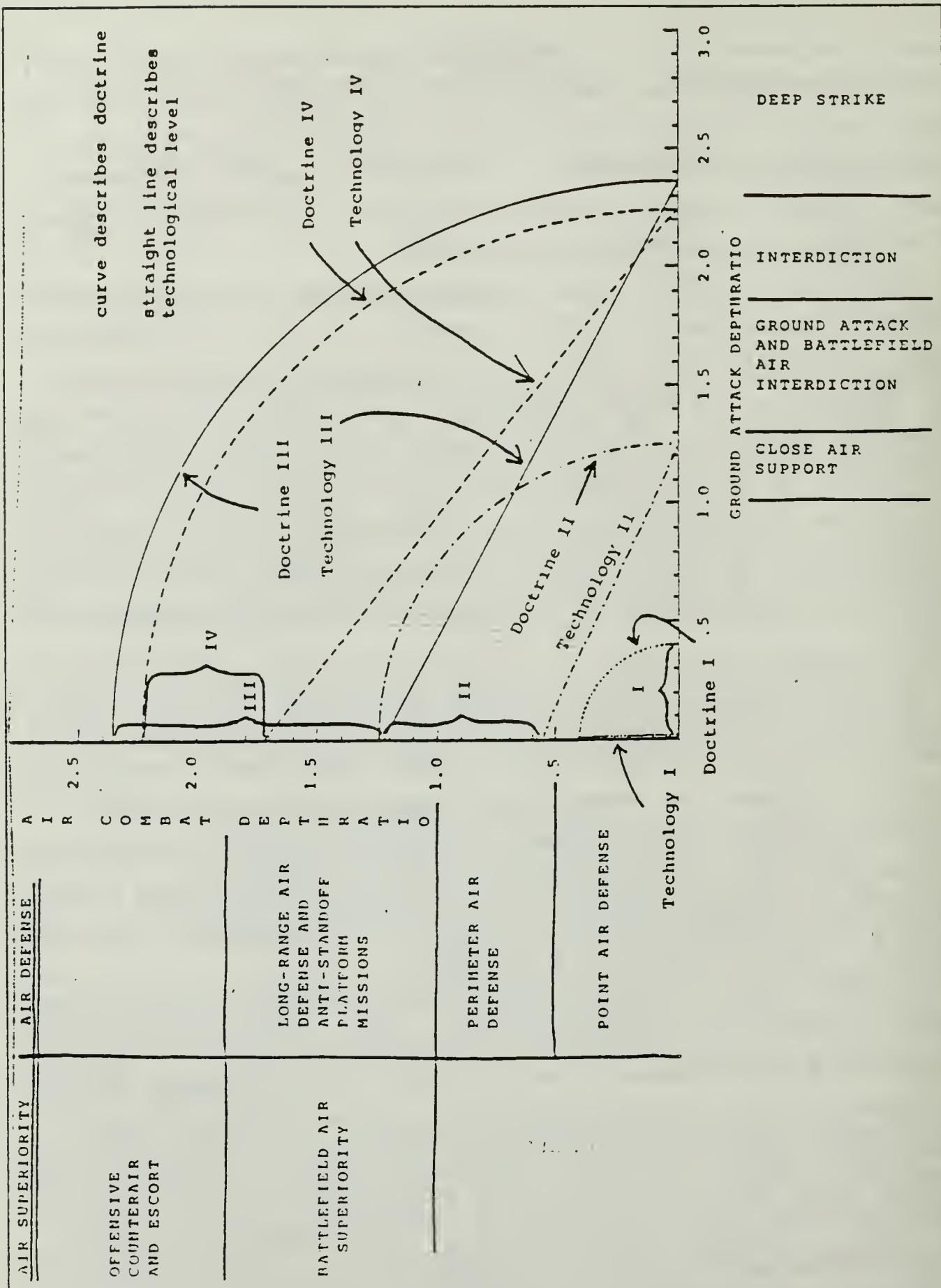


Figure 38. Technology-Doctrine Convergence

the battlefield air superiority role), Period III was characterized by an imbalanced force, deficient in air combat capability.

The most recent period has seen a slight movement downward of doctrinal requirements at the same time as the fighter force has seen an increase in air combat capability. This simultaneous convergent movement has reduced the disparity between doctrinal requirements and fighter force capability to its lowest point in the postwar period.<sup>179</sup>

The slight movement downward of doctrinal requirements was not, strictly speaking, a reduction in Soviet visions for the scope and depth of air combat in a future war. It reflects the reorganization of the Soviet air forces and the design of new aircraft that "fill in" gaps left in the wake of the very rapid postwar growth in ground attack capability.

The reorganization of the Soviet air forces resubordinated, among others, some of the aircraft with the greatest DEPTH RATIO values (the SU-24 FENCER) up to a command echelon with a greater depth of responsibility than the command echelon at which they had previously been controlled. This had the effect of reducing the DEPTH RATIO values for that aircraft, which explains part of the downward movement. The other explanation lies in SUKHOI's design of the SU-25 FROGFOOT close air support fighter. This aircraft is designed to operate at very shallow depths (no deeper than the FEBA) in dedicated support to the front-level ground forces. Since its DEPTH RATIO value is unity, the average ground attack DEPTH RATIO for Period IV was expected to decrease.

The most interesting element, however, of the fourth period's doctrine-technology relationship is the increase in air combat technological sophistication, a large part of which is due to the design of the SU-27 FLANKER. The SU-27, with a high thrust-to-weight ratio, low wingloading, wing-body blending (for good high-angle-of-attack performance), large internal volume (for good combat radius), as well as a new advanced radar and AAM's, should confer on Soviet force planners and pilots a much greater potential for effective air combat than they have had in the past. The FLANKER's DEPTH RATIO of 2.33 makes it a natural choice for escorting the SU-24 FENCER in interdiction and deep strike missions. In fact, no other air combat fighter is capable of performing this role.. Thus, the SUKHOI OKB has provided

---

<sup>179</sup>Period I, which DEPTH RATIO values of .40 and 0.0, must be considered to have had an infinite deficiency, although the difference is less than that for Period IV.

Soviet force planners with both the ground attack and air combat aircraft needed for the deep strikes and offensive counterair missions of a theater-wide strategic conventional operation, as well as the capability to execute the earlier theater nuclear offensive.

## VI. TECHNOLOGY AND DOCTRINE IN PERSPECTIVE

*(A MIG on your tail is better than no MIG at all)*

The analysis thus far has attempted to compare the most easily-observed characteristics and performance figures for postwar Soviet fighters with the apparent employment concept prevalent at the time of each fighter's design. The evolution of these two phenomena can be depicted in tabular form, as shown in Table XIV.

TABLE XIV  
EVOLUTION OF SOVIET FIGHTER DESIGN  
AND AIR EMPLOYMENT DOCTRINE

	<u>FIGHTER DESIGN</u>	<u>AIR EMPLOYMENT DOCTRINE</u>
1945-1953	air defense	ground attack
1954-1964	continued air defense, beginning interest in ground attack, recce, ambivalence in design reflected in VEW	air defense
1964-1973	ground attack	theater nuclear offensive, ground attack, recce, role of tactical air uncertain
1973-1985	air combat	theater conventional offensive

This figure simply captures in brief form what has already been argued in detail; that Soviet fighter design has not only progressed largely independently of doctrinal requirements, but in fact appears to have driven the development of tactical air employment doctrine over the past forty years. Each period has been marked by a divergence between force structure and doctrine. Doctrine has changed over the years in order to incorporate the most advanced technical capability, without apparent consideration given to the need for balance in the fighter force mix and its convergence with employment doctrine. Figure 38 (page 106) depicts the direction and magnitude

of various correctives, but thus far, the Soviets ultimately appear to be at the mercy of technological innovation; their doctrine must continually react to it in order to incorporate it, and later, the resulting force imbalance and capability-doctrine divergence must be addressed.

This state of affairs, however, is an unfortunate one for threat assessment. It represents a sort of good news/bad news situation: the good news for the West is that Soviet technological development puts the cart before the horse and results in a confused capability-doctrine relationship that could prove disastrous to the USSR in time of war; the bad news is that periodically the Soviets correct the situation (only to be faced again with the same cycle of events). Where, then, does that leave us? What other variables must be "factored in" to the problem? What will add to the context within which Western analysts must consider the Soviet air threat? These questions are dealt with in this final section.

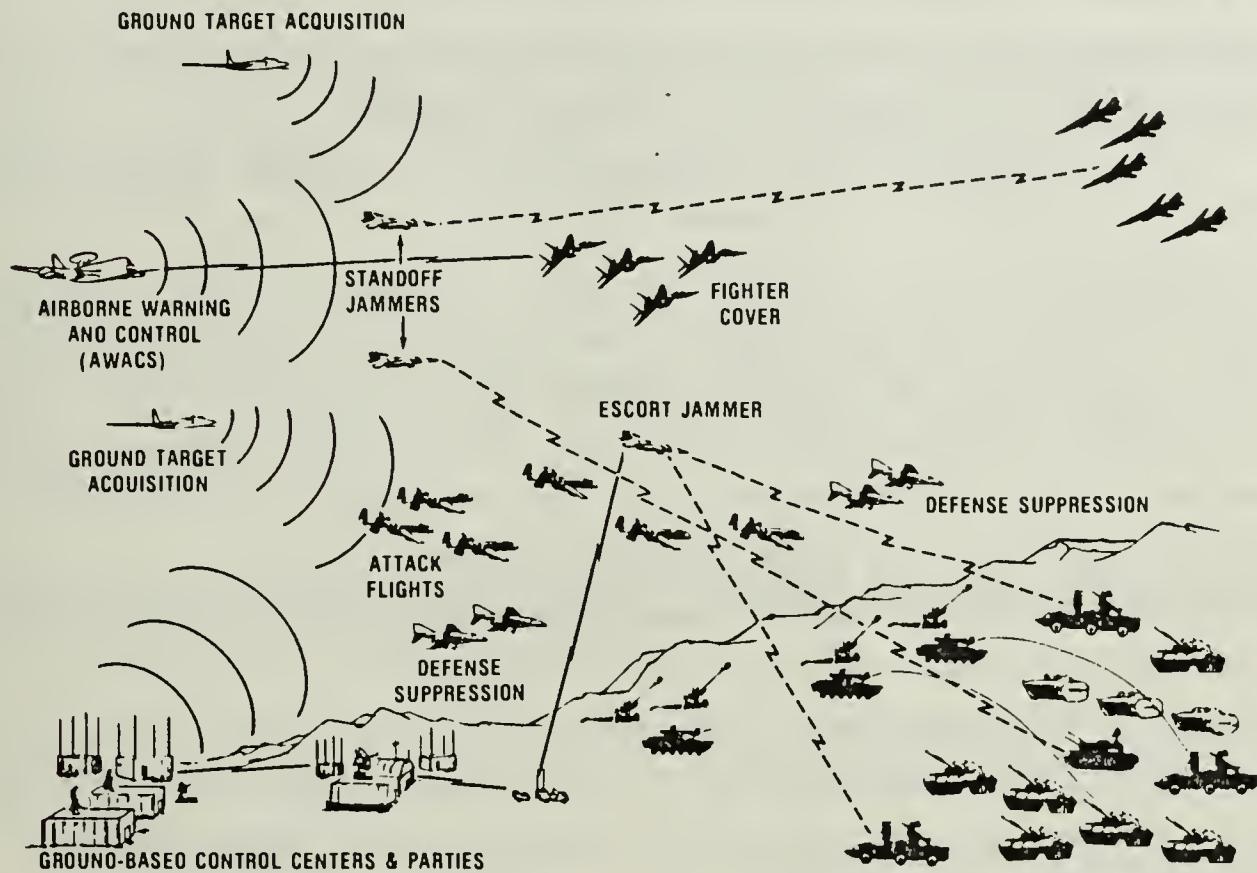
#### A. GROUND ATTACK

The challenges faced by the Soviets in the ground attack arena are in many ways the same problems any air force would face (i.e., the "reconnaissance-target engagement cycle is the same); in other ways, the Soviets have some unique problems posed by the nature of their doctrinal requirements and the stultifying effects of their political culture.

An air force seeking to deliver firepower beyond the FEBA faces a considerably more complex task than simply arming a "ground-pounder" and launching it on its way. A very large number of functions must be performed in the course of the reconnaissance-target engagement cycle, no less for the Soviets than for anybody else. In addition, the precise nature of these functions will change slightly depending upon the depth of the proposed mission. For example, a deep strike may require escort or aerial refueling, while a close air support mission may require real-time coordination with friendly air defense units and deconfliction with friendly artillery and air assets in the immediate vicinity of the proposed attack. Figure 39 (next page) depicts the wide range of components possible in a modern ground attack mission.

Because not everything in combat can be predicted and preplanned, provision must be made for ascertaining the "true state of the battlefield" at any given time. This information is typically provided by reconnaissance and intelligence assets to the commander, who in turn generates commands to pursue certain objectives at the

expense of others. This cybernetic control process is at the heart of the reconnaissance-target engagement cycle.



Source: Seymour J. Deitchman, *Military Power and the Advance of Technology*, (Boulder, Westview Press, 1983), p. 41.

Figure 39. Components of a Modern Ground Attack Mission

Reconnaissance of potential targets can come from many sources, including ground patrols and a wide range of reconnaissance (recce) platforms (e.g., dedicated reconnaissance aircraft, other friendly air missions in the area, satellites, etc.). This reconnaissance information must be collected, processed (film developed, tapes read, pilots debriefed, etc.), and sent to the central tactical air controlling agency, where it must be combined with reports coming from other sectors of the front. At some point, the number of targets being nominated for attack will exceed the capacity of the system and a process of elimination should organize the remaining targets by priority. This determination typically involves such factors as the importance of a target in depth or the time-urgency of an engaged target on the active battlefield.

Once the commander has coordinated all his incoming information and determined his priorities, he can generate the tasking orders (commands) that set the target-engagement phase in motion. The tasking order must take into account, in addition to reconnaissance/intelligence data, the state and availability of friendly forces (number of aircraft and crews available, fuel and munitions stocks, support assets needed and available, attrition rates, etc.). When the tasking order arrives at the operational unit (for the SAF, this would be a fighter-bomber or bomber regiment), the actual mission-planning can begin. It is possible that a "heads-up" warning might come down to the regiment earlier, when it becomes obvious to the centralized tactical air controlling agency that certain missions are highly probable. In this way, the "nuts and bolts" of mission-planning can begin, even in the absence of known strike package sizes, support aircraft authorizations, and time-on-target requirements. This entire process, including the strike itself and the subsequent battle damage assessment, is often designed into a 24-hour cycle.

Obviously, in the case of mobile targets, the reconnaissance-target engagement cycle must be so compressed that the target does not move very far from the location of its original sighting before it is attacked. This compression requires that certain targets receive "special handling" in the reporting process and that less senior commanders be given enough discretion and latitude to depart from the original plan and attack fleeting "targets of opportunity." While these are universal characteristics of the reconnaissance-target engagement cycle, they are precisely the sorts of things the Soviets may be poor at doing.

The Soviets' bureaucracy-burdened society (including the military) is ill-equipped to handle departures from the expected and the planned. Soviet command and control

procedures, including attack planning, is quite rigid and has in the past allowed very little flexibility. Its highly-specific preplanning, highly-centralized decision-making, and high penalties for unauthorized deviations make very unlikely the effective and efficient prosecution of a war as complex as is likely to be encountered in the NATO Central region.<sup>180</sup>

Quoting Soviet Lieutenant Colonel A. Zakharenko, Joshua Epstein cites Soviet combined air-ground efforts, in which

"the results of air strikes against the enemy were of no consequence to the gunners. Their rounds often struck the same areas that had just previously been worked from the air." Tellingly, they add, "the duplication did not stem from any desire to achieve the maximum possible suppression of the enemy, but from uncoordinated decisions . . . Was this fire required? With what density? It's difficult to say. We had no bomb damage assessment data available."<sup>181</sup>

Epstein also notes "inefficiencies within the Soviets' system of processing and distributing reconnaissance information."<sup>182</sup> He argues that "staff skills have failed to keep up with the increased tempo of modern combat."<sup>183</sup> Again citing Lt. Col. Zakharenko, Epstein notes that

ground force "combined arms commanders don't have an in-depth knowledge of aviation subunits and, in turn, aviators can only judge the development of the ground battle in the most general terms."<sup>184</sup>

Thus, the necessary coordination between Soviet air and ground components may be sorely lacking.

These problems may be magnified with the adoption of the OMG and its concept of employment. The OMG, to be effective, must engage in imaginative raiding and must have a wide latitude for its maneuver. As we have seen, however, the Soviets do not typically raise a good crop of daring and imaginative commanders in peacetime. To make matters worse for the Soviets, the OMG should operate in an area of

---

<sup>180</sup> *Strengthening Conventional Deterrence*, p. 48.

<sup>181</sup> Joshua M. Epstein, *Measuring Military Power: The Soviet Air Threat to Europe* (Princeton: Princeton University Press, 1984), p. 114. Citing Lt. Col. A. Zakharenko, "The Lessons of Coordination," *Krasnaya Zvezda*, 5 August 1977, p. 1.

<sup>182</sup> Epstein, *Measuring Military Power*, p. 117.

<sup>183</sup> Epstein, *Measuring Military Power*, p. 118.

<sup>184</sup> Epstein, *Measuring Military Power*, p. 120.

undisputed air superiority. It may be able to do this only if it operates within the corridors opened up by the Air Operation.<sup>185</sup> This, however, would make the OMG easy to find, less maneuverable, and quite predictable.

As far as the Air Operation itself is concerned, it is by no means certain to be a success. The Warsaw Pact offensive in general, and the Air Operation in particular, is supposed to be a highly-integrated, minutely-synchronized series of events "dependent upon a constant flow at a predetermined rate."<sup>186</sup> The Air Operation requires extreme preplanning of launch and recovery times, ingress and egress routes, altitude and time blocks, coordinated air defense and escort operations, and synchronized times-on-target.<sup>187</sup> If anything goes wrong or happens unexpectedly, the Soviets may not be sufficiently able to improvise. Marxist-Leninist "insights" and scientific planning notwithstanding, von Clausewitz' "fog" and "friction of war" make combat unpredictable.

## B. AIR COMBAT

In the air combat arena, the Soviets have shown themselves in the past to be lacking in initiative and creativity. In fact, lack of initiative is a real problem in the SAF, in which peacetime training is typically routinized and unrealistic.<sup>188</sup> General Lieutenant of Aviation G. Pavlov complains that "the pilots imitating the target fly only in a straight line, without changing altitude or speed."<sup>189</sup>

"Soviet operational practices are surprisingly 'pro forma' with little continuing effort to enhance their skills under realistic conditions. Many of their sorties appear to be rather canned, once around the flagpole and back. In short, they appear to maintain their flying skills, but not their combat proficiency."<sup>190</sup>

---

<sup>185</sup>"Resource limitations may well dictate that the corridor of air superiority established for the conduct of the air operation must be coordinated with the air-cover corridors created to protect the OMG's." *Strengthening Conventional Deterrence*, p. 132.

<sup>186</sup>*Strengthening Conventional Deterrence*, p. 62.

<sup>187</sup>Jeffrey S. Johnson, *Initiative in Soviet Air Force Tactics and Decision Making*, (Master's Thesis, Naval Postgraduate School, Monterey, California, June 1986), p. 109.

<sup>188</sup>Johnson, *Initiative*, p. 97.

<sup>189</sup>Epstein, *Measuring Military Power*, p. 100, citing General Lieutenant of Aviation G. Pavlov, "Inexhaustible Reserve," *Krasnaya Zvezda*, 4 August 1976, p. 2.

<sup>190</sup>Epstein, *Measuring Military Power*, p. 101, citing Edward T. Timperlake and Steven Leveen, "A Methodology for Estimating Comparative Aircrew Proficiency," a report prepared for the Theater Forces Division, Office of Strategic Research, Central Intelligence Agency (Arlington: The Analytic Sciences Corporation, 1981), pp. 7-25.

Epstein goes on to quote the Directorate of Soviet Affairs, Air Force Intelligence Service, as saying: "Pilots fly the same patterns over the same ranges year after year and then perform poorly when conditions are varied ever so slightly."<sup>191</sup> This lack of initiative, hitherto characteristic of Soviet fighter pilots, is in "consonance with well-known Soviet operational practice," in which "the Soviets place heavy stress on the importance of GCI directives in shaping the contours of the [air] engagement."<sup>192</sup> Benjamin Lambeth points out that

for years, going as far back as World War II, the Soviet Air Force has resisted the idea of allowing its pilots much independence and has instead <sup>193</sup> stressed the importance of maintaining close control over its fighters at all times.

Because the Soviets "routinely export their operational style along with their arms transfers to client states," it is reasonable to look for clues to Soviet performance in that of the Chinese (in the Korean War), the North Vietnamese, and the Syrians.<sup>194</sup> In Korea, Chinese- and Soviet-flown MIG's typically had a thrust-to-weight ratio advantage over the US F-86 Sabres; by maintaining maximum speed, the MIG pilots retained their energy advantage and were able to fly with near impunity in the vertical plane. In Vietnam, several "extenuating circumstances" led to multi-turn dogfights, despite the seemingly large technological lead of the US F-4 Phantom over enemy fighters.<sup>195</sup>

---

<sup>191</sup> *Measuring Military Power*, p. 102, citing Directorate of Soviet Affairs, Air Force Intelligence Service, *Soviet Press Selected Translations*, April 1977, p. 86.

<sup>192</sup> Benjamin S. Lambeth, "Moscow's Lessons from the 1982 Lebanon Air War," a Project Air Force Report prepared for the United States Air Force (Santa Monica: Rand, 1984), p. 1.

<sup>193</sup> Lambeth, "Moscow's Lessons," p. 20.

<sup>194</sup> Lambeth, "Moscow's Lessons," p. 29.

<sup>195</sup> "During the early years of the Vietnam conflict the low-wing-loaded, low-T/W [thrust-to-weight] MIG-17 FRESCO opposed the US F-4 Phantom. With nearly a ten-year technology advantage, a powerful air-to-air radar, semi-active radar-guided Sparrow missiles, RQ [rear quarter] head-seeking Sidewinders, and supersonic speed capability, the Phantom might have been considered more than a match for the subsonic, guns-only MIG-17. Several extenuating circumstances, however, greatly altered the balance. The long-range, all-aspect Sparrow missile, for instance, often could not be used, since it was usually impossible to identify the target as hostile except visually at close range. By that time the MIG-17 was probably inside the weapon's minimum-range capabilities and tended to remain there during subsequent maneuvering. Since this missile was not 'dogfight capable,' and the Phantoms generally lacked gun armament, only the RQ Sidewinder remained viable against the more maneuverable MIG. Even so, energy tactics should have allowed the F-4 to escape or to remain neutrally engaged until the MIG pilot lost sight or had to retire. Unfortunately for the Americans, the Phantom crews often were poorly trained in

In more recent year, however, Syrian performance against the Israeli Air Force (IAF) and the attendant Soviet analysis of those engagements may provide some important clues as to the current state of Soviet air combat skills and preferences. During the June 1982 air battles over Lebanon, the IAF jammed voice- and data-links between Syrian aircraft and their GCI sites.<sup>196</sup> This caused the Syrians to lose "any semblance of air discipline and [the Syrians] quickly became split up into isolated pairs and singles."<sup>197</sup> Lambeth goes on to say that "the Soviet Air Force currently operates under a similar close-control doctrine and would be comparably vulnerable to enemy jamming interference."<sup>198</sup> As we have seen, however, the Soviets are now receiving "equipment that would allow it, in principle, to go well beyond that restrictive operating doctrine."<sup>199</sup> Lambeth's analysis of the Soviets' lessons from the 1982 air engagements suggests that while the Soviets may "have this problem increasingly in mind," they nevertheless drew some fundamentally wrong conclusions from the combat, particularly regarding the true threat from all-aspect missiles and the subsequent requirements for their employment. These interpretations, Lambeth concludes, offer "ground for guarded encouragement among American fighter pilots."<sup>200</sup>

### C. TOWARD THE YEAR 2000

The technologies incorporated into the Soviets' new SU-27 FLANKER and MIG-29 FULCRUM seem optimized not solely for the high-altitude, high-speed, BVR, "single-pass shot" type of engagement, but also for the best possible performance in the primary maneuver region (less than Mach 1.0 and 10,000-30,000 foot altitudes).<sup>201</sup> This

---

energy techniques, were faced with a much smaller enemy aircraft that was hard to track visually, and sometimes lacked the combat endurance for extended engagements far from their bases. These circumstances often led to hard-turning engagements, to the advantage of the MIG's. The MIG's also were generally blessed with better ground-based radar control and could spot and identify the Phantoms at long distances because the F-4 engines smoked badly. Therefore, the MIG's often reached a firing position, or at least gained substantial advantage, before being detected." Robert L. Shaw, *Fighter Combat: Tactics and Maneuvering* (Annapolis: Naval Institute Press, 1985), p. 175.

<sup>196</sup>Lambeth, "Moscow's Lessons," p. 6.

<sup>197</sup>Lambeth, "Moscow's Lessons," p. 9.

<sup>198</sup>Lambeth, "Moscow's Lessons," p. 21.

<sup>199</sup>Lambeth, "Moscow's Lessons," p. 20.

<sup>200</sup>Lambeth, "Moscow's Lessons," p. 27.

<sup>201</sup>In practice, high-Mach speeds are not very useful in combat. They use up fuel at enormous rates and severely restrict maneuverability. At high altitudes as well, turning performance is limited.

may reflect increasing Soviet interest in close maneuver combat.<sup>202</sup> If this trend is as strong as its proponents insist, it would represent a sharp departure from the recent past, in which Soviet fighter pilots have typically been GCI-bound and notably lacking in initiative. However, the new technologies incorporated into recent designs certainly seem compatible with greater pilot autonomy in at least two respects. First, if the new fighters (SU-27 FLANKER and MIG-29 FULCRUM) are indeed intended for "intruder"-type missions beyond the FEBA, they will be operating outside of GCI range. The pilots of these aircraft will then have no choice but to exercise a degree of independent thinking not previously seen in the postwar Soviet Air Force. Second, the close combat maneuvering that these aircraft make possible may also place unremitting demands on pilot creativity and initiative. Finally, the history of Korea and Vietnam suggest that the Soviets are not incapable of maneuvering air combat.

General Lieutenant N. N. Ostroumov has written that in front-controlled aviation, preference will be given to aerial engagements with enemy aircraft, while in theater-controlled operations, preference will be given to attacking enemy aircraft on their own airfields.<sup>203</sup> This distinction suggests that the long-range kill might be sought in the course of escorting the air operation, perhaps in order to limit the disruption to the planned execution of that effort. Maneuvering engagements might be more likely to take place after frontal aircraft had been released back to the subordinate commands from which they had originally been requisitioned. This interpretation is supported by Jeffrey Johnson's argument that the Air Operation (ground attack) commanders have historically "stifled" the initiative that air superiority fighter pilots would like to develop.<sup>204</sup>

It has been argued in any event, that if both sides are increasingly equipped with long-range all-aspect missiles, then it is possible that air combat will not progress beyond the initial head-on pass. A better explanation for incorporating both long- and

---

<sup>202</sup>"Close maneuver combat . . . has been recognized by the Soviets and increasing emphasis on independent tactics and pilot initiative is evident in recent Soviet aviation publications." Rana Pennington, "Pilot Initiative in the Soviet Air Forces," Murphy, *The Soviet Air Forces*, p. 152. The 1985 issue of the DOD's *Soviet Military Power*, says that "since 1980, fundamental changes have occurred in Soviet fighter tactics and training. The introduction of an air-to-air combat training program, incorporating air combat in a visual environment against maneuvering targets, is a significant step forward" (pp. 86-87).

<sup>203</sup>General Lieutenant of Aviation N. N. Ostroumov, cited in Phillip A. Petersen and Major John R. Clark, "Soviet Air and Antiair Operations," *Air University Review*, March-April 1985, Vol. 36, no. 3, pp. 36-54.

<sup>204</sup>Johnson, *Initiative*, p. 11.

close-range kill mechanisms into modern Soviet fighters may simply lie in the expected nature of a future war and the nature of tactical engagements. In the electromagnetic environment likely to be encountered in the NATO Central Region, many of the long-range systems on air combat fighters simply will not work. Second, even off-boresight, all-aspect weapons have optimum launch envelopes. Thus, the aerial engagement that otherwise might have evolved into a BVR "face shot" or a long-range, off-boresight kill, may come to involve maneuvering into a shorter-range kill envelope and "degenerating" into a classical "dogfight." This appears to be a scenario the Soviets may be anticipating. In the past, NATO has typically had an advantage over the Soviet Air Force in maneuvering in the vertical plane and fighting at higher altitudes, where Soviet fighters could not maintain their maneuver energy. However, the Soviets have maneuvered in the past and appear increasingly interested in challenging the current NATO superiority in that arena. They will attempt to do this with new weapons, new tactics and new force employment concepts.

If the Soviets are able to overcome the institutional drag that has thus far plagued their society and military, as well as fix the apparent shortcomings in their reconnaissance-target engagement cycle; if they are able to flawlessly execute the Air Operation, establishing their air superiority over NATO and eliminating NATO's nuclear arsenal at the very outset of a war; if they are able to make the Operational-Maneuver Group concept and the new command and control arrangements work; and, last but not least, if Soviet fighter pilots are able to ride a very steep learning curve in the first day or two of a European war and survive, then the Soviets may indeed win the next war very quickly, without resorting to the use of nuclear weapons. Until then, however, even with new weapons and advanced technology, Soviet tactical air superiority is as much an illusion as Icarus' unthinking disregard for the circumstances and context surrounding his own disastrous flight.

## APPENDIX A

### THE DATA BASE

The data base is described in the following manner: each entry contains the name of a variable and what that variable measures or describes. In addition, some entries contain further comments (type of data, ground rules, numerical derivations, definitions, etc.).

*AIRADAR*: air intercept radar (1 = yes, 0 = no);

*AIRSRCHAZ*: air intercept radar search azimuth;

*ARM*: antiradiation missile (1 = yes, 0 = no);

*ASM*: air-to-surface missile (1 = yes, 0 = no);

*ASPECT*: wing aspect ratio (wingspan squared divided by wing area);

*CALIBER*: caliber of largest gun;

*CEILING*: combat ceiling;

*CHORD*: wing thickness to chord ratio;

*CLIMBRATE*: aircraft rate of climb;

*CRADIUS*: combat radius (for air combat, subsonic area intercept; for ground attack, HI-LO-HI and 50% ordnance)

*DESIGNYEAR*: year of aircraft design;

*DIGITALINK*: digital data link (1 = yes, 0 = no);

*DOPPNAV*: doppler navigation (1 = yes, 0 = no);

*ECHELON*: depth of responsibility of command echelon to which aircraft is assigned (front = 160nm, ADD = 608nm, theater = 270nm)

*ECM*: electronic countermeasures (1 = yes, 0 = no)

*EMPTYWGT*: aircraft empty weight;

*ENDURE*: endurance (time aircraft can remain aloft in combat configuration);

*ENGINES*: number of engines;

*ENGINETYPE*: type of engines (engine make and model number);

*EXFUEL*: external fuel capacity;

*FIRSTFLT*: year of aircraft's first flight;

*FUELFRAC*: fuel fraction (fraction of maximum weight taken up by full fuel load);

*GARADAR*: ground attack radar (1 = yes, 0 = no);

*GLIMIT*: aircraft G-limit;

*GROUNDRUN*: takeoff ground run (distance in feet aircraft in combat configuration requires for takeoff)

*GUNS*: number of guns on aircraft;

*HUD*: head-up-display (1 = yes, 0 = no);

*INFUEL*: internal fuel capacity;

*INNAV*: inertial navigation (1 = yes, 0 = no);

*IOC*: initial operational capability (year of IOC);

*IRSTS*: infrared search and track system (1 = yes, 0 = no);

*LASDES*: laser designator (1 = yes, 0 = no);

*LASRANGE*: laser ranging device (1 = yes, 0 = no);

*LDSD*: lookdown/shootdown capability (1 = yes, 0 = no);

*LED*: lift-enhancing devices (1 = yes, 0 = no);

*MACHSL*: maximum sea-level airspeed (MACH);

*MANEUVER*: maneuverability [ratio of TWRATIO to combat wingloading (combat weight divided by wing area)]

*MAXPOWER*: maximum engine thrust;

*MILPOWER*: maximum non-afterburning engine thrust;

*MSLRANGE*: maximum air-to-air missile (AAM) range (for radar-guided AAM's.  
high-altitude, head-on, fighter-size target; for infrared-guided AAM's, look-up,  
tail-aspect, fighter-size target)

*NUMBERMSLS*: maximum number of AAM's;

*OKBCODE*: design bureau code (1 = MIG, 2 = SUKHOI);

*ORDNANCE*: maximum weight of ground attack ordnance, or air-to-air weapons,  
whichever is greater

*PERIOD*: period of aircraft's design (1 = 1945-1953, 2 = 1954-1964, 3 = 1964-1973,  
4 = 1973-1985)

*RECCE*: reconnaissance capability (photographic, SLAR, infrared, electronic;  
1 = yes, 0 = no)

*RWR*: radar warning receiver (1 = yes, 0 = no);

*SEARCH*: air intercept radar search range;

*SPANLOAD*: spanloading (combat weight divided by wingspan);

*STALLSPD*: aircraft stall speed;

*STATIONS*: number of weapons pylons on aircraft;

*TERRAVOID*: terrain avoidance radar (1 = yes, 0 = no);

*TERRFOLL*: terrain following radar (1 = yes, 0 = no);

*TOTALFUEL*: total fuel capacity;

*TRACK*: air intercept radar track range;

*TRACKSCN*: track-while-scan radar (1 = yes, 0 = no);

*TWRATIO*: thrust-to-weight ratio [maximum afterburning thrust divided by combat  
weight (50% fuel, 100% weapons)]

*VGW*: variable-geometry wing (1 = yes, 0 = no);

*WINGLOAD:* wingloading (combat weight divided by wing area);

*WINGSWEET:* wingsweep (sweep of wing leading edge).

The aircraft that comprised the data base were the following:

MIG-15 FAGOT (A), MIG-15 FAGOT(B)

MIG-17 FRESCO A, MIG-17 FRESCO B, MIG-17 FRESCO C,  
MIG-17 FRESCO D, MIG-17 FRESCO E

MIG-19 FARMER A, MIG-19 FARMER B, MIG-19 FARMER C,  
MIG-19 FARMER D, MIG-19 FARMER E

MIG-21 FISHBED A, MIG-21F FISHBED C, MIG-21PF FISHBED D,  
MIG-21PFM FISHBED F, MIG-21R FISHBED H, MIG-21MF FISHBED J,  
MIG-21SMT FISHBED K, MIG-21bis FISHBED L, MIG-21bisF FISHBED N

MIG-23 FLOGGER A, MIG-23M FLOGGER B, MIG-23MF FLOGGER G

MIG-27BM FLOGGER D, MIG-27BN FLOGGER J

MIG-25 FOXBAT A, MIG-25R FOXBAT B/D, MIG-25M FOXBAT E

MIG-29 FULCRUM

MIG-31 FOXHOUND

SU-7B FITTER A, SU-7BM FITTER B, SU-7BKL FITTER B

SU-9 FISHPOT B

SU-11 FISHPOT C

SU-15 FLAGON A, SU-15 FLAGON D, SU-15 FLAGON E, SU-15 FLAGON F

SU-17 FITTER C, SU-17 FITTER D, SU-17 FITTER H, SU-17 FITTER K

SU-24 FENCER A, SU-24 FENCER B, SU-24 FENCER C, SU-24 FENCER D

SU-25 FROGFOOT

SU-27 FLANKER

## APPENDIX B

### SAMPLE METHODOLOGY

The following weights were assigned to ECHELON values:

#### **MIG-23 FLOGGER A/B/G:**

6% theater  
76% front  
18% air defense district

#### **MIG-25 FOXBAT A/E:**

30% front  
70% air defense district

#### **MIG-25R FOXBAT B/D:**

12% theater  
88% front

#### **MIG-29 FULCRUM:**

30% theater  
30% air defense district  
40% front

#### **SU-24 FENCER:**

65% theater  
35% front

#### **SU-27 FLANKER:**

30% theater  
30% air defense district  
40% front

For example, the calculations to determine the DEPTH RATIO value for the MIG-29 FULCRUM were as follows:

30% x 270nm (weighting factor x theater depth)

30% x 608nm (weighting factor x ADD depth)

40% x 160nm (weighting factor x front depth)

327nm = ECHELON value

DEPTH RATIO = CRADIUS/ECHELON

DEPTH RATIO = 620/327 = 1.89 = MIG-29 FULCRUM DEPTH RATIO

## BIBLIOGRAPHY

Adelman, Jonathan R. "The Evolution of Soviet Military Doctrine, 1945-1985," *Air University Review*, March-April 1985. Washington D.C.: US Government Printing Office, 1985.

Alexander, Arthur J. *Decision-Making in Soviet Weapons Procurement*. Adelphi Papers 147, 148. Lethworth: Garden City Press, 1978.

\_\_\_\_\_. *Soviet Science and Weapons Acquisition*. Santa Monica: Rand Corporation, 1982.

Amick, Daniel J. and Walberg, Herbert J. *Introductory Multivariate Analysis*. Berkeley: McCutchan Publishing Corporation, 1975.

Arkin, William M. and Fieldhouse, Richard W. *Nuclear Battlefields: Global Links in the Arms Race*. Cambridge: Ballinger Publishing Company, 1985.

Armitage, M. J. and Mason, R. A. *Air Power in the Nuclear Age*. Urbana: University of Illinois Press, 1983.

Aspaturian, Vernon V. "The Soviet Military-Industrial Complex--Does It Exist?" *Journal of International Affairs* vol. 26, no. 1, 1972.

*Aviation Week and Space Technology* as cited.

Baker, John C. and Berman, Robert P. *Soviet Strategic Forces: Requirements and Responses*. Washington, D.C.: Brookings Institution, 1982.

Berman, Robert P. *Soviet Air Power in Transition*. Washington, D.C.: Brookings Institution, 1978.

Boyd, Alexander. *The Soviet Air Force Since 1918*. New York: Stein and Day, 1977.

Deane, Michael J.; Kass, Ilana; and Porth, Andrew G. "The Soviet Command Structure in Transformation," *Strategic Review*, Spring 1985.

Deitchman, Seymour J. *Military Power and the Advance of Technology*. Boulder: Westview Press, 1983.

Dick, C. J. "Soviet Operational Maneuver Groups--A Closer Look," *International Defense Review* vol. 16, no. 6, 1983.

Dinerstein, Herbert S. *War and the Soviet Union: Nuclear Weapons and the Revolution in Soviet Military and Political Thinking*. New York: Praeger, 1959.

Dole, Charles E. *Flight Theory and Aerodynamics*. New York: John Wiley and Sons, 1981.

Donnelly, Christopher, ed. *Strengthening Conventional Deterrence in Europe: Proposals for the 1980's*. Boston: Nimrod Press, 1983.

Donnelly, C. N. "The Soviet Operational Maneuver Group," *International Defense Review*, vol. 15, no. 9, 1983.

Douglass, Joseph D. *The Soviet Theater Nuclear Offensive*. Washington, D.C.: US Government Printing Office, 1976.

Eisenbeis, Robert A. and Avery, Robert B. *Discriminant Analysis and Classification Procedures*. Lexington: D. C. Heath and Company, 1972.

Epstein, Joshua M. *Measuring Military Power: The Soviet Air Threat to Europe*. Princeton: Princeton University Press, 1984.

Evangelista, Matthew. "Why the Soviets Buy the Weapons They Do," *World Politics* vol. 36, no. 4, July 1984.

Futrell, R. F. *The United States Air Force in Korea*. New York: Duell, Sloan and Pearce, 1961.

Gallagher, Matthew P. and Spielmann, Karl F. *Soviet Decisionmaking for Defense: A Critique of US Perspectives on the Arms Race*. Boulder: Westview Press, 1972.

Garthoff, Raymond. *Soviet Strategy in the Nuclear Age*. New York: Praeger, 1959.

Gormley, Dennis M. and Hart, Douglas M. "Soviet Views on Escalation," *The Washington Quarterly*, Fall 1984. Boston: MIT Press Journals, 1984.

Goure, Leon, Kohler, Foy D. and Harvey, Mose L. *The Role of Nuclear Forces in Current Soviet Strategy*. Miami: Center for Advanced International Studies, 1974.

Gunston, Bill. *Aircraft of the Soviet Union*. London: Osprey Publishing, 1983.

Gunston, Bill and Spick, Mike. *Modern Air Combat*. New York: Crown Publishers, 1983.

Gunston, Bill and Sweetman, Bill. *Soviet Air Power*. London: Salamander Books Ltd., 1978.

Hale, Francis J. *Introduction to Aircraft Performance, Selection and Design*. New York: John Wiley, 1984.

Higham, Robin and Kipp, Jacob W., eds. *Soviet Aviation and Air Power*. Boulder: Westview Press, 1977.

Holloway, David. *The Soviet Union and the Arms Race*. New Haven: Yale University Press, 1983.

Hough, Jerry. "The Brezhnev Era: The Man and the System," *Problems of Communism*, March-April 1976.

International Institute for Strategic Studies. *The 1985-1986 Military Balance*. Letchworth: Garden City Press, 1985.

*Janes All the World's Aircraft* as cited.

*Janes Defence Weekly* as cited.

Johnson, Jeffrey S. *Initiative in Soviet Air Force Tactics and Decision Making*. Master's Thesis, Naval Postgraduate School, Monterey, California, June 1986.

Kachigan, Sam Kash. *Multivariate Statistical Analysis: A Conceptual Introduction*. New York: Radius Press, 1982.

Kim, Jae-On and Mueller, Charles W. *Introduction to Factor Analysis: What It Is and How to Do It*. Beverly Hills: Sage University Paper Series on Quantitative Applications in the Social Sciences (07-013), 1978.

Khrushchev, Nikita S. *On Peaceful Coexistence*. Moscow: Foreign Languages Publishing House, 1961.

Kilm Marx, Robert A. *A History of Soviet Air Power*. New York: Frederick A. Praeger, 1962.

Kozhevnikov, M. N. *The Command and Staff of the Soviet Army Air Force in the Great Patriotic War, 1941-1945*. Moscow: Voenizdat, 1977.

Kozlov, S. "The Development of Soviet Military Science After World War II," in *Voennaya Mysl'*, February 1964. Moscow: Voenizdat, 1964.

Kozlov, V. and Sushko, N. "The Development of Marxist-Leninist Teaching on War and the Army," in *Voennaya Mysl'*, April 1968. Moscow: Voenizdat, 1968.

*Krasnaya Zvezda* as cited

Lambeth, Benjamin S. *Moscow's Lessons from the 1982 Lebanon Air War*. Santa Monica: Rand Corporation, 1984.

\_\_\_\_\_. "Pitfalls in Force Planning: Structuring America's Tactical Air Arm," *International Security* vol. 10, no. 2, (Fall), Cambridge: MIT Press, 1985.

\_\_\_\_\_. *Trends in Soviet Military Policy*. Santa Monica: Rand Corporation, 1982.

Lee, Asher. *The Soviet Air and Rocket Forces*. New York: Praeger, 1959.

\_\_\_\_\_. *The Soviet Air Force*. London: Duckworth, 1961.

LeGrow, Allan Wesley. *Measuring Aircraft Capability for Military and Political Analysis*. Master's Thesis, Naval Postgraduate School, Monterey, California, June 1976.

Lomov, N. A., ed. *Scientific-Technical Progress and the Revolution in Military Affairs*. Moscow: Voenizdat, 1973.

McConnell, James M. *The Soviet Shift in Emphasis From Nuclear to Conventional: The Mid-Term Perspective*. CRC 490-Vol. II. Alexandria: Center for Naval Analysis, 1983.

McDonnell, John A. "The Soviet Weapons Acquisition System," *Soviet Armed Forces Review Annual* Vol. 3. Gulf Breeze: Academic International Press, 1979.

Meyer, Stephen M. *Soviet Theater Nuclear Forces*. Adelphi Papers 187, 188. Letchworth: Garden City Press, 1983.

Miller, Mark E. *Soviet Strategic Power and Doctrine: The Quest for Superiority*. Coral Gables: Current Affairs Press, 1982.

Murphy, Paul, ed. *The Soviet Air Forces*. Jefferson: McFarland and Company, 1984.

Nicolai, Leland M. *Fundamentals of Aircraft Design*. San Jose: METS, 1984.

Ogarkov, Nikolai V. *Always in Readiness to Defend the Homeland*. Moscow: Voenizdat, 1982.

\_\_\_\_\_. *Istoriya Uchit' Bditel'nosti*. Moscow: Voenizdat, 1985.

Penkovskiy, Oleg. *The Penkovskiy Papers*. New York: Doubleday, 1965.

Petersen, Phillip A. *Soviet Air Power and the Pursuit of New Military Options*. Washington, D.C.: US Government Printing Office, 1978.

Petersen, Phillip A. and Clark, John R. "Soviet Air and Antiair Operations," *Air University Review*, March-April 1985. Washington, D.C.: US Government Printing Office, 1985.

Petersen, Phillip A. and Hines, John G. "The Conventional Offensive in Soviet Theater Strategy," *Orbis*, Fall 1983.

Pokrovskiy, G. I. *The Role of Science and Technology in Modern War*. Translated by Raymond Garthoff. Moscow: Voenizdat, 1956.

Ponamarev, A. N. *Aviatsiya Nastoyashchego I Budushchego*. Moscow: Voenizdat, 1984.

*Pravda* as cited.

Record, Jeffrey. *NATO's Theater Nuclear Force Modernization Program: The Real Issues*. Washington, D.C.: Corporate Press, Inc., 1981.

Ridgway, Matthew B. *The Korean War*. New York: Doubleday, 1967.

Rotmistrov, P. "On the Role of Surprise in Contemporary War," *Voennaya Mysl'*, February 1955. Moscow: Voenizdat, 1955.

Rummel, R. J. *Applied Factor Analysis*. Evanston: Northwestern University Press, 1970.

Savkin, V. Ye. *The Basic Principles of Operational Art and Tactics*. Moscow: Voenizdat, 1972.

Schlesinger, Robert J. *Principles of Electronic Warfare*. Los Altos: Peninsula Publishing, 1961.

Shaw, Robert L. *Fighter Combat: Tactics and Maneuvering*. Annapolis: Naval Institute Press, 1985.

Scott, Harriet Fast and Scott, William F. *The Armed Forces of the USSR*. Boulder: Praeger, 1979.

Scott, Harriet Fast and Scott, William F., eds. *The Soviet Art of War: Doctrine, Strategy and Tactics*. Boulder: Westview Press, 1982.

Sidorenko, A. A. *The Offensive*. Moscow: Voenizdat, 1970.

Sokolovskiy, V. D. *Military Strategy*, 1st ed. Translated by Herbert S. Dinerstein; Leon Goure; Thomas W. Wolfe. Moscow: Voenizdat, 1963.

~~Sokolovskiy, V. D. *Military Strategy*, 3rd ed. Translated by Harriet Fast Scott. Moscow: Voenizdat, 1968.~~

~~\_\_\_\_\_. *Military Strategy, Soviet Doctrine and Concepts*. London: Pall Mall, 1963.~~

Sutton, Anthony. *Western Technology and Soviet Economic Development, 1945-1965*. Stanford: Hoover Institution, 1973.

Talenskiy, N. "On the Question of the Character of the Laws of Military Science," *Voennaya Mysl'*, November 1953. Moscow: Voenizdat, 1953.

Urban, Mark L. "Major Reorganization of Soviet Air Forces," *International Defense Review* no. 6, 1983.

US Air Force. *Selected Readings from 'Military Thought', 1963-1973*. Washington, D.C.: US Government Printing Office, 1982.

US Department of Defense. *Soviet Acquisition of Militarily Significant Western Technology: An Update*. Washington, D.C.: US Government Printing Office, 1985.

US Department of Defense. *Soviet Military Power 1985*. Washington, D.C.: US Government Printing Office, 1985.

Valenta, Jiri and Potter, William, eds. *Soviet Decisionmaking for National Security*. London: George Allen and Unwin, 1984.

*Washington Post* as cited.

Wolfe, Thomas W. *Soviet Power and Europe 1945-1970*. Baltimore: Johns Hopkins Press, 1970.

## INITIAL DISTRIBUTION LIST

	No. Copies
1. Defense Technical Information Center Cameron Station Alexandria, Virginia 22304-6145	2
2. Library, Code 0142 Department of National Security Affairs Naval Postgraduate School Monterey, California 93943-5000	2
3. Center for Naval Analyses 2000 North Beauregard Street P.O. Box 11280 Alexandria, Virginia 22311	1
4. AFIT/PA Wright-Patterson AFB, Ohio 45433	1
5. Air University Library Maxwell AFB, Alabama 36112	1
6. Center for Aerospace Doctrine, Research and Education CADRE Maxwell AFB, Alabama 36112	1
7. HQ USAFA DFSEL Library Colorado Springs, Colorado 80840-5701	1
8. 7452 Special Activities Squadron (USAFE) APO NY 09742-5000	1
9. Prof. Jan Dellenbrant Department of Soviet and East European Studies Svartbackgatan #7 S75230 Uppsala, Sweden	2
10. Department Chairman, Code 56 Department of National Security Affairs Naval Postgraduate School Monterey, California 93943	1
11. Prof. Kerry M. Kartchner, Code 56K <sub>n</sub> Department of National Security Affairs Naval Postgraduate School Monterey, California 93943	1
12. Prof. Robert Looney, Code 56L <sub>x</sub> Department of National Security Affairs Naval Postgraduate School Monterey, California 93943	1
13. Prof. Patrick J. Garrity, Code 56G <sub>y</sub> Department of National Security Affairs Naval Postgraduate School Monterey, California 93943	1

14.	Prof. Brian Dailey, Code 56Di Department of National Security Affairs Naval Postgraduate School Monterey, California 93943	1
15.	Prof. Ed Laurance, Code 56Lk Department of National Security Affairs Naval Postgraduate School Monterey, California 93943	1
16.	Prof. Frank Teti, Code 56Tt Department of National Security Affairs Naval Postgraduate School Monterey, California 93943	1
17.	Prof. Robert B. Bathurst, Code 56Ba Department of National Security Affairs Naval Postgraduate School Monterey, California 93943	1
18.	Dr. Howard Weinberg Naval Center for International Science and Technology Naval Postgraduate School Monterey, California 93943	1
19.	Net Assessment Branch Office of the Secretary of Defense Pentagon Washington, D.C. 20301	1
20	HQ USAF/INE Pentagon Washington, D.C. 20301	1
21.	Director of Soviet Affairs, AFIS Bolling AFB Washington, D.C. 20332	1
22.	Mr. Jim Peak Defense Intelligence Agency Pentagon Washington, D.C. 20332	1
23.	TAC/IN Langley AFB, Virginia 23665	1
24.	USAFE/IN APO NY 09012	1
25.	CIA/SOVA Central Intelligence Agency Langley, Virginia 20505	1
26.	Capt. Steven K. Black 1038 Spruance Road Monterey, California 93940	2





43  
17663/7



TITLE NUMBER: Dudley Knox Library, Naval Postgraduate School  
LIBRARY: Monterey, Ca 93943

CUSTOMER NUMBER:

ROSWELL  
BOOKBINDING

LIBRARY DIVISION

Binding in  
Everything

CONTENTS

F	B	NP

INDEX

Bind without Index

ISSUE CONTENTS

Discard


Bind in Place

Gather at Front

IN	OUT

Advertisements

Front Covers

Back Covers

1st only

Accents

Imprints

Special Instructions:

STEVEN K. BLACK  
Thesis B545552

Buck Color	598
Print Color	Gold
Trim Height	
Hi Inches	
Over Thick	
For Title	
Extra Lines	
Extra Coll	
Hand Sew	
Slit	
Rules	
1st Slot No	
Vol Slot No	
Year Slot No	
Call # Slot	
Imp Slot No	
Type Face	
Price	
Mending	
Map Pockets	
2 Vols in 1	

ACTUAL TRIM	DATE
SPINE	JOB
BOARD DIM	LOT
CLOTH DIM	ROUTE
CLOTH BIN	SEQ. NO.

43  
17663/7









DUDLEY KNOX LIBRARY  
NAVAL POSTGRADUATE SCHOOL  
MONTEREY CALIFORNIA 93943-5002

220131

Thesis

B545552 Black  
c.1 The Icarus illusion:  
technology, doctrine and  
the Soviet Air Force

26 JAN 90  
5 JUN 97

35779  
38006

220131

Thesis

E545552 Black  
c.1 The Icarus illusion:  
technology, doctrine and  
the Soviet Air Force

thesB545552  
The Icarus illusion:



3 2768 000 68118 3

DUDLEY KNOX LIBRARY